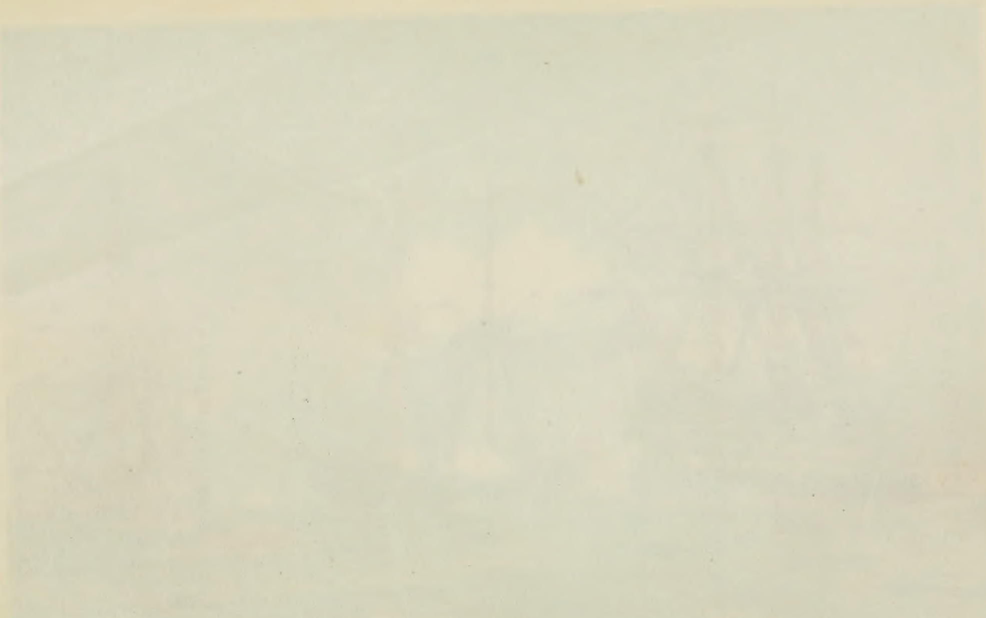
STEAM-SHIPS



THE "WILLIAM FAWCETT," THE FIRST P. & O. STEAM-SHIP, 209 TONS, BUILT 1829.

ON THE LEFT IS A BOMB KETCH, A TYPE WITHDRAWN FROM THE NAVY ABOUT THIS DATE.

ON THE RIGHT IS H.M.S. "ST. VINCENT," 101 GUNS.

From a Painting by Charles Dixon

By kind permission of the Peninsular & Oriental Steam Navigation Co.

STEAM-SHIPS

THE STORY OF THEIR DEVELOPMENT TO THE PRESENT DAY

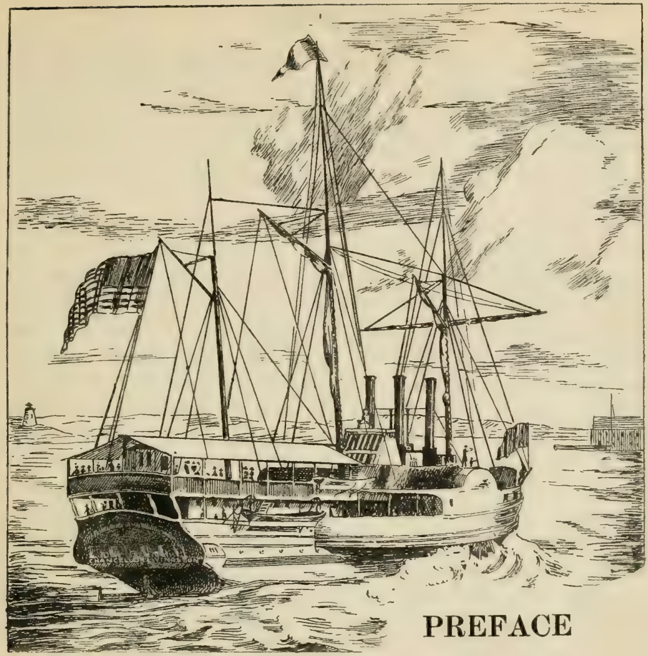
BY

R. A. FLETCHER

WITH A HUNDRED AND
FIFTY ILLUSTRATIONS

PHILADELPHIA
J. B LIPPINCOTT COMPANY
LONDON: SIDGWICK & JACKSON, LTD.
1910

Printed in England



PREFACE

THE story of the Steam-ship, and of its development up to the present time, covers little more than a hundred years. In the companion volume,* the evolution of the sailing ship necessitated a comprehensive survey of some eight centuries; but that we need vessels, not only faster than the sailing ship, but also more independent of the weather conditions, is shown by the fact that in the world's shipping tonnage of to-day (omitting small vessels) the proportion of steam to sail is as nine to one. The "seven seas" must be crossed with speed and safety, in the interest of all nations that have a mile of sea coast; but the Anglo-Saxon race, as it has con-

* "Sailing Ships and their Story," by E. Keble Chatterton, 1909.

tributed—from either side of the Atlantic—most largely to the mechanical and structural development of the steam-ship, now depends most vitally upon the organisation of its naval and transportation systems. Napoleon said that the strength of an army lay in its feet; no less true is it that the strength of our Empire lies in her ships.

A hundred years ago it was impossible to forecast with any accuracy how long a journey might take to accomplish, and the traveller by land or sea was liable to "moving accidents by flood and field"; but side by side with the growth of the steam-ship, and the accompanying increase of certainty in the times of departure and arrival, came the introduction of the railway system inland. Between the two, however, there is the fundamental difference that the sea is a highway open to all, while the land must be bought or hired of its owners; and the result of this was that inland transportation, implying a huge initial outlay on railroad construction, became the business of wealthy companies, whereas any man was free to build a steamboat and ply it where he would. The shipowner, moreover, has a further advantage in his freedom to choose his route, because he is at liberty to "follow trade"; but if, as has happened before now, the traffic of a town decreases, owing to a change in, or the disappearance of, its manufactures, the railway that serves it becomes proportionately useless.

In another essential, the development of steam-transport on land and sea provides a more striking contrast. The main features of George Stephenson's "Rocket" showed in 1830, in however crude a form as regards detail and design, the leading principles of the modern locomotive engine and boiler; but the history of the marine engine, as of the steam-ship which it propels, has been one of radical change.

The earliest attempts were made, naturally enough, in the face of great opposition. Every one will remember Stephenson's famous retort, when it was suggested to him that it would be awkward for his engine if a cow got across the rails, that "it *would* be very awkward—for the cow";—and at sea it was the rule for a long while

to regard steam merely as auxiliary to sails, to be used in calms. While ships were still built of wood, and while the early engines consumed a great deal of fuel in proportion to the distance covered, it was impossible to carry enough coal for long voyages, and a large sail-area had still to be provided. Progress was thus retarded until, in 1843, the great engineer Brunel proved by the *Great Britain* that the day of the wooden ship had passed; and the next ten years were marked by the substitution of iron for wood in shipbuilding.

Thenceforward the story of the steam-ship progressed decade by decade. Between 1855 and 1865 paddle-wheels gave place to screw propellers, and the need for engines of a higher speed, which the adoption of the screw brought about, distinguished the following decade as that in which the "compound engine" was evolved. Put shortly, "compounding" means the using of the waste steam from one cylinder to do further work in a second cylinder. The extension of this system to "triple expansion," whereby the exhaust steam is utilised in a third cylinder, the introduction of twin screws, and the substitution of steel for iron in hull-construction, were the chief innovations between 1875 and 1885. The last fifteen years of the century saw the tonnage of the world's shipping doubled, and the main features of mechanical progress during that period were another step to "quadruple expansion" and the application of "forced draught," which gives a greater steam-pressure without a corresponding increase in the size of the boilers. The first decade of the present century has been already devoted to the development of the "turbine" engine.

I have to thank the Institute of Marine Engineers at Stratford, E., for much valuable assistance and for placing its *Transactions* at my disposal; if I have not acknowledged every item derived therefrom I trust that this general acknowledgment will suffice. To Mr. J. Kennedy, author of "The History of Steam Navigation"; Mr. A. J. Maginnis, author of "The Atlantic Ferry"; and Captain James Williamson, author of "The Clyde Passenger Steamer," I am greatly indebted for their kind permission to draw freely upon their books: and to the publishers of the two latter, Messrs. Whittaker

and Co. and Messrs. MacLehose and Sons respectively, for the loan of illustrations. Special thanks are also due to Mr. E. A. Stevens of Hoboken, New Jersey, U.S.A., not only for information concerning the experiments made by Colonel Stevens with the screw propeller, but also for the loan of some unique photographs of early American boats. Mr. A. J. Dudgeon, M.I.N.A., M.I.C.E., son of the well-known Thames shipbuilder, has revised a large amount of my work, and was good enough to place at my disposal his valuable scrap-books, from the pictures in which my friend Mr. Ernest Coffin has drawn several charming line-illustrations and the initial letters to the chapters. For various assistance I have to thank other friends and correspondents: Mr. James A. Smith, M.I.N.A; Mr. Harry J. Palmer, formerly of *Shipping Illustrated*, New York, and now assistant to Captain Clark, Lloyd's agent at New York; Mr. J. W. Little, of Messrs. Little and Johnson; and Mr. James Gallagher of Paris for his researches at the Academy of Sciences and elsewhere.

For permission to reproduce many illustrations of models, &c., in the Science Museum at South Kensington, I am indebted to the Board of Education; while for particular information I am glad to acknowledge the especial courtesy of Messrs. Barclay, Curle and Co., Ltd., of Whiteinch, Messrs. R. and W. Green, Ltd., Messrs. Swan, Hunter, and Wigham Richardson, Ltd.; and, for revising the portion relating to Floating Docks and supplying illustrations thereof, to Messrs. Clark and Standfield. To many other famous shipbuilding firms who have supplied material or illustrations thanks must also be tendered: Messrs. Harland and Wolff of Belfast; Messrs. A. and J. Inglis of Glasgow; Messrs. Thornycroft and Co., Ltd.; the Carron Company; Messrs. Yarrow; Messrs. Eltringham and Co., Ltd.; Messrs. Smith's Docks Co., Ltd.; Messrs. Palmer's Shipbuilding and Iron Co., Ltd.; Messrs. Armstrong, Whitworth and Co., Ltd.: the Parson's Marine Steam Turbine Co., Ltd.; the Thames Iron Works and Shipbuilding Co., Ltd.; the Vulcan Shipbuilding Co. of Stettin; Messrs. W. Denny and Brothers, Ltd., of Dumbarton; Messrs. Osbourne Graham and Co., Ltd.; Messrs. William Gray and Co., Ltd.; Sir Raylton Dixon and Co. of Middlesbrough; Messrs. W. Doxford and

Sons of Sunderland ; and the Newport News Shipbuilding and Dry Dock Company, U.S.A.

To many shipowing firms I and my publishers are alike indebted for information and the loan of illustrative material; the Peninsular and Oriental Steam Navigation Co., Ltd. ; The Cunard Company; the White Star Line; the American Line; the Pacific Steam Navigation Company ; the Orient Line; Messrs. Shaw, Savill and Co., Ltd.; Lund's Blue Anchor Line; the Royal Mail Steam Packet Company ; Messrs. Elder, Dempster and Co., Ltd ; the General Steam Navigation Company ; the Isle of Man Steam Packet Company, Ltd. ; the principal Railway Companies owning steam-ships ; the Anchor Line ; the Allan Line; Messrs. Brocklebank and Co. ; the Bibby Line; Messrs. George Thompson and Son's Aberdeen Line; the North German Lloyd, and the Hamburg-American Line.

Certain illustrations appear by arrangement with the editors of the *Magazine of Commerce*, the *Shipping World*, the *Syren and Shipping*, the *Master*, *Mate*, *and Pilot* (of New York), the *Engineer*, and the *Shipbuilder*. The photograph of the *Minas Geraes* is reproduced by special permission of his Excellency the Chief of the Brazilian Naval Commission.

R. A. Fletcher

June 1910

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

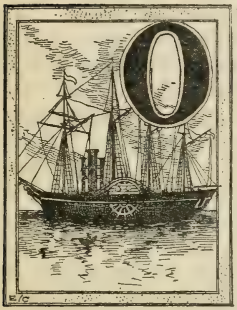
LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

PLANS

CHAPTER I

PRIMITIVE EXPERIMENTS IN PROPULSION—SOME EARLY EXPERIMENTS WITH STEAM

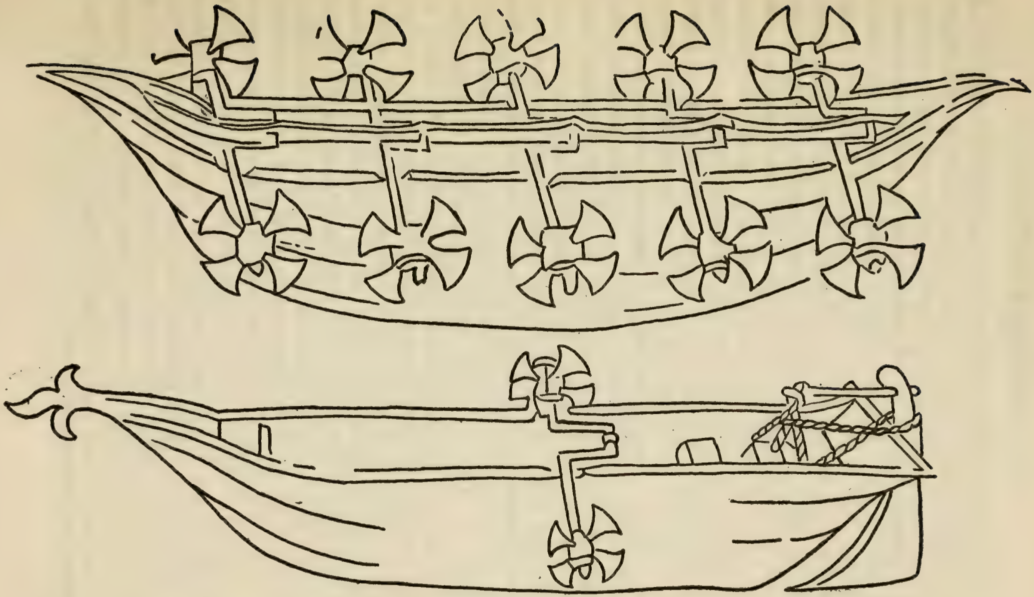


OPINIONS are divided as to whether the paddle-wheel is a development from the action of a man paddling a canoe, or the result of applying to a vessel an ordinary wheel, with blades to make it bite the water; or it may be stated thus: Did the paddle-blades grow out of the wheel, or the wheel out of a number of paddle-blades? There is no satisfactory evidence one way or the other; suffice it that the idea of revolving paddles was developed.

How the power which caused the revolution of the paddles was applied at first is as unknown as the identity of the man who first thought of making navigation easier by mechanical means. It was probably human power, as the first inventor can hardly have discovered how to utilise animals for the purpose, and from what we know of primitive expedients we may conjecture what the first contrivance used to urge a boat onwards without sails or oars was like. The craft would be a small one. Perhaps the proprietor was too poor to hire rowers. Perhaps, a subtle financier, he realised that if he could bring his goods to a certain place before rival shippers he would secure the market. Hence, stimulated by poverty or cupidity or both, he reflected, experimented, and finally

invented the revolving paddle. But his apparatus was probably nothing more than a smooth, straight branch or tree log, which projected over either side of the boat and carried at each end paddles fixed radially. He probably used two or four paddles, as it would be easier to attach them to the axle in pairs. The radii of the paddles consisted of two poles tied at right angles about the middle and there fastened to the axle ends, rough-hewn boards or strips of bark being attached at the extremities of the poles to form the paddle-blades. The axle was doubtless kept in place either by pins in the gunwales placed before and after it, or by bringing two of the ribs on either side above the gunwale line and disposing the axle between them. In many modern row-boats one or other of these plans is adopted for the accommodation of the oars or sculls. This much being accomplished, it only remained to apply the power. The inventor now passed a rope twice round the middle of the axle, and tied the ends together. By hauling on it he got all the power he was likely to require ; to go astern he had merely to pull the rope the other way. If more power was required more men tugged at the rope.

When paddles were made larger to suit hulls of larger dimensions, it may fairly be assumed that a winch turned by several men was used, and that the power was transmitted to the axle of the paddle by means of an endless rope. But soon it occurred to the shipowners that animals might be used to produce the power instead of men. Horses or oxen were made to drive a turntable or capstan, to work in a cage after the fashion of white mice in their cylinders, or on a moving floor which imparted its motion to an axle connected by an endless rope with the axle of the paddle. Such boats, deriving their power from animals, were built by the Romans, were in use in the early centuries of the Christian era, and were not unknown in the nineteenth century in Britain and the United States.



PRIMITIVE PADDLE-BOATS.

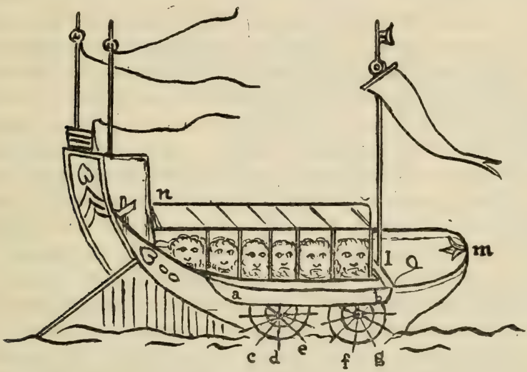
From Valturius' "De Re Militari," 1472.

One of the earliest authentic records of a vessel fitted with paddle-wheels is to be found in Robertus Valturius' "De Re Militari," published in 1472, wherein are pictures * of two boats, one of which has five pairs of paddle-wheels, and the other one pair. Modern engineers know by experience that if two wheels be placed one behind another —and in the early days of steam navigation several boats were equipped with two pairs of paddle-wheels—the hinder wheels, having to work in disturbed and moving water, are practically useless. But at the time of which Valturius writes the wheels were so small, the number of revolutions were so few, and the propelling power they exerted so slight, that no wheel was likely to have its efficiency much interfered with by any number of wheels in front of it. The wheels had four paddles each, and were revolved by cranks on their axles, the cranks of the ten-wheeled boat being connected by a rope to give uniform action.

In the Far East also, wheel-boats were in use long before steam-driven paddle-wheels were invented. The Chinese certainly used them. In a paper read at the Society of Arts in April 1858, Mr. John McGregor, a barrister, who devoted considerable time to the study of early mechanical appliances, stated that an old work on China contains a sketch of a vessel moved by four paddle-wheels, and used perhaps in the seventh century. In certain "Memoires" of the Jesuit Fathers at Peking, published at Paris in 1782, there appears this quaint description of a "barque à roues": "This vessel is 42 feet in length and 13 feet in width. The wheels are fixed in an empty space about a foot high situate underneath the strip between the stout planks *a b*. From the axle or centre of the wheels any number of spokes radiate which act like teeth for the wheels. They enter the water to the depth of a foot. A number of men make the wheels turn round. The length

* The designs have been attributed to Matteo de' Pasti, who lived at the court of Malatesta (d. 1464).

of the prow from *l* to *m* is 8 feet. The length of the body of the vessel from *n* to *o* is 27 feet, and the length of the poop 7 feet. Heads of tigers are represented on movable boards covered with leather, about 5 feet in height and 2 feet wide. These boards shelter from the



"Barque à Roues," Primitive Chinese Paddle-boat.

enemy the soldiers who are behind them. They are removed when the crew decide on boarding the enemy's vessel." The good Fathers in their "Memoires" add a recommendation to experts in Paris to study the principle with a view to its adoption in French vessels, and they point out that even if the extra speed attained were ever so slight it might be sufficient to bring a vessel out of a dangerous situation. It may well be doubted, however, whether the shipping experts in Paris at that date profited by this humanitarian suggestion. Be this as it may, the passage proves that the propulsion of vessels by revolving wheels was not a western idea only.

Panciroli, writing in the sixteenth century, describes an

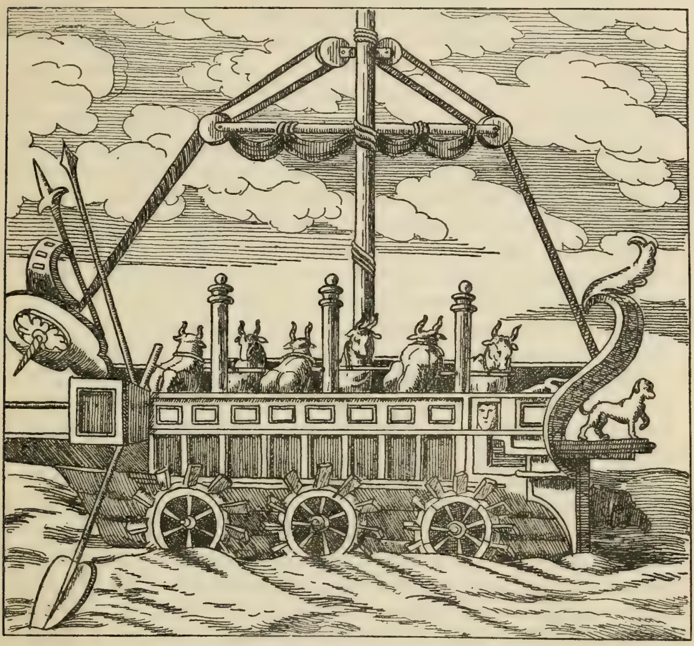
extraordinary boat of which he had seen a picture. His book is not illustrated; but we find a representation of a *liburna*, or galley, which exactly corresponds to Panciroli's description,* in Morisotus' (Claude Barthélemy Morisot) "Orbis Maritimi . . . generalis Historia," published in 1643.

The vessel, an Illyrian galley, had six wheels propelled by as many oxen. The curious picture suggests an unwieldy, top-heavy concern which could only be of use in still water, and would probably be safest in shallow water, so that if anything happened the oxen and men could walk ashore without trouble. The cattle apparently occupy most of the space, an immense bird's head with a hooked nose juts out in front immediately above the waterline; this is of course the ram, above which is a platform upon which a dog stands as the vessel's figure-head.

It is unnecessary to go in detail into all the schemes devised by inventors and visionaries for propelling vessels by mechanical means. Several of them from time to time suggested placing wheels on the outside of the boat, and "turning the wheeles by some provision so that the wheeles make the boat goe," to quote William Bourne's proposition of 1578, but the "some provision" constituted a problem which he and many others found too much for them. David Ramsay in 1618 took out a patent "to make boats for carriages running upon water as swift in calms and more safe in storms than boats full sailed in great winds," and twelve years later another patent is recorded to his credit for making ships and barges go against the tide. The optimism of these and other

* "Vidi etiam effigiem Navium quarundam, quas Liburnas dicunt; quæ ab utroque latere extrinsecus tres habebant rotas, aquam attingentes: quarum quælibet octo constabat radiis, manus palmo e rota prominentibus: intrinsecus vero sex boves machinam quandam circumagendo rotas illas incitabant: et radii aquam retrorsum pellentes, Liburnam tanto impetu ad cursum propellebant, ut nulla triremis ei posset resistere."—Guido Panciroli: *Rerum memorabilium*, libri ii. Ambergæ, 1599.

mechanical pioneers was wonderful; indeed, had their inventive genius only equalled their imagination, some of the difficulties which until comparatively recently baffled



"LIBURNA" OR GALLEY, WORKED BY OXEN.
From Morisotus.

naval engineers and marine architects would have been long since overcome.

The webbed feet of water-birds suggested to many a form in which mechanical propulsion could be applied.

This was only natural, as early shipbuilders took as their models the birds which they saw floating before them. In 1759 a Swiss pastor named Genevois published at Geneva a proposal to use an oar fitted with a foot which should expand when used for propelling a boat and contract when being moved forward through the water for another stroke. Genevois visited London in 1760 to lay his proposal before the Government. His propellers were to be worked by springs which in turn were to be compressed by a kind of cannon with a piston. A pamphlet which he issued at the time of his application to the Government contains the interesting statement that he had been informed that a Scotchman had propounded a scheme thirty years earlier for propelling vessels forward by the recoil from the firing of cannon over the stern. The gunpowder of the period made up in smoke what it lacked in power; hence, although the vessels of his day were not large, the ingenious Scot "found, by the experiments made for that purpose, that thirty barrels of Gun-powder had scarce forwarded the ship the space of ten Miles"; and it is not surprising that this means of mechanical propulsion shared the fate of all of its predecessors.*

Many other extravagant schemes might be quoted. Edward Ford in 1646 was quite modest in his patent to "bring little ships, barges, and vessels in and out of any havens without or against any small wind or tide," to which he cautiously added the qualification "if the seas be not rough." With the exception, however, of a few sporting proposals of which the Scotch Gunpowder Plot is a type, no advance in solving the problem of producing the power for propulsion was made for centuries. The burden of physical exertion had been shifted from men to animals, but that was all; and yet in every age during the last two thousand years there seem to have been many

* "Some New Inquiries tending to the Improvement of Navigation," by J. A. Genevois, 1760.

people who were acquainted with the expansive power of steam, a fact which makes this slow development the more remarkable.

The first person to observe the properties of steam, or at any rate the first to record his observations, was Hero of Alexandria in 120 B.C., but though he advanced from theory to practice, his æolipile does not seem to have answered any useful purpose. This machine consisted of a hollow glass ball supplied with steam at its axis. The steam escaped by means of a series of hollow tubes, placed at right angles and projecting from the globe at a circle on its circumference equidistant from the two poles, the tubes being closed at the ends and provided with orifices at the sides near the ends. Nothing came of his invention, so far as is known, and the æolipile remained an interesting toy and nothing else—a toy, however, which has the honour of being the first mechanical contrivance in which the expansive power of steam was used. After this, for many centuries, no attempt was made to use this great natural agency for the purpose of producing what Bacon called "fruits" for mankind. Unscrupulous priests worked "miracles" by this means for the edification of their flocks, and doubtless revived thereby many whose faith had become lukewarm. It never seems to have occurred to them that a far more direct means of moving mountains was already under their control.

At last in 1629 the use of steam as a means of producing power was suggested by Giovanni Branca of Loretto, who, apparently adopting a simplified form of Hero's device, planned so that a jet of steam blew against a series of vanes arranged on the rim of a wheel.

In the seventeenth century also, that eccentric genius the second Marquis of Worcester published his "Century of Inventions." In this he suggested a number of mechanical contrivances, some of which contained the fundamental ideas of later inventions, the most notable

being that of a steam-engine with a piston and lever; but he does not seem to have designed any vessel which would justify the claim sometimes made on his behalf that he was the inventor of the steamboat.*

About the same time, Sir S. Morland, another experimenter, estimated the expansive force of water at 2000 times, in which he was not far from the truth.

England, however, was not the only country to produce inventors. One Blasco de Garay, who flourished a hundred years before the Marquis of Worcester, is declared by his champions to have been the first to solve the problem of propelling a vessel by steam-power. But investigations as to the accuracy of the story tend to the belief that he did nothing of the kind, and that the beautifully circumstantial account of his experiment does greater credit to the imagination of the narrator than to his regard for accuracy.† De Garay's experiment was made at Barcelona in the year 1543 in the presence of representatives of the Emperor Charles V. Ravago, the Treasurer, reported to the Emperor that the vessel would go two leagues in three hours, but that the machine was complex and expensive, and that the cauldron in which the steam was generated might burst. This is exactly the report which a cautious financier, presumably not an expert in mechanics, might be expected to make. Other reports were more favourable to the project, the commissioners appointed for the purpose ascribing to the vessel a speed of a league an hour. What has been established beyond question, however, is that De Garay made the experiment with a boat fitted with paddle-wheels, but that the wheels were turned by men and not by steam.

Salomon de Caus, a native of Normandy, is sometimes

* Partington's edition of the "Century of Inventions."

† Mr. John McGregor reported to the Society of Arts that the claim that De Garay used a steam-engine is unfounded, human power being used.

claimed by French writers to have first thought of using steam as a motive power in 1615, but his invention does not seem to have fructified. Half a century later the unlucky Doctor Denis Papin, a native of Blois, entered the field of invention. He came to this country from France in 1675, was elected a Fellow of the Royal Society in 1681, and in 1690 described a steam cylinder fitted with a piston which descended by atmospheric pressure when the steam below it was condensed. He suggested that one of the uses to which his engine might be put was the revolution of paddle-wheels fitted to a ship, several cylinders being applied which worked alternately with the rackwork he designed. He may have been led to this by witnessing in 1681 the experiments on the Thames with a boat designed by Rupert, the Prince Palatine, with revolving fans, which easily left behind a boat manned by a number of oarsmen. It has been claimed for Papin that he was the inventor of the safety-valve, but this is disputed.* Prior, however, to his atmospheric engine he brought out in 1685 a machine for raising or pumping water, but the Royal Society treated it with contempt and referred to it as a "mere trick." Neither of his machines received the recognition which historians have since decided was their due, and he went back disheartened to France, whence he was driven by the Revocation of the Edict of Nantes to Marburg. He reappeared in England in 1707 and announced a project for moving ships by means of wheels and steam. Unfortunately for him, Thomas Savery, born in 1658, had already been at work on the problem, and had brought out his fire-engine, which among other things he thought might be used to propel ships. His machine lacked power, and was replaced by one made after the design of his partner Newcomen. Papin was also associated with Newcomen and Savery at one time. Savery says of his own machine that he would refer the question

* Hy. Frith's "Triumphs of Steam."

of its suitability for shipping to those more competent than himself to judge. Papin appealed to the Naval Department to consider his invention, but the Government of the day, after the manner of Governments when face to face with a new project, thought it useless, and made severe remarks on his presumption in continuing to invent for them. He exhibited his invention on the Thames, but no one took any interest in it. Thoroughly disheartened by the failures which attended all his efforts, Papin went to Germany, and is stated to have there built a steamer which was actually tried on the Fulda or the Weser, but the local watermen, fearing the rivalry of the new machine, smashed it, and that is the last which history has to record of Papin as a pioneer of steamboats. It is asserted that this boat was built for him by Newcomen and Savery in this country. As an experimenter he did valuable work, for he seems to have been the first to have grasped the importance of the vacuum under the piston.*

In 1730 another remarkable proposition was made for marine propulsion. Doctor John Allen thought it possible to move a boat by pumping in water at the bows and pumping it out again at the stern, this scheme being probably the earliest attempt to secure motion by what has since become known as the jet-propeller system. Like almost all other inventions of his period it was crude in its details and does not seem to have been put to any practical use.

The next inventor who turned his attention to the question was Jonathan Hulls, for whom it has been claimed, with some show of justification, that he was the actual inventor of the steamboat. That he did invent a steamboat is beyond question, but whether his vessel was ever built, and if so whether it attained any measure of success, are points upon which historical evidence is not conclusive. But if it was constructed, and there is strong

* Lindsay's "History of Merchant Shipping."

circumstantial evidence in support of this contention, then to the West of England, which has contributed so largely to the maritime glory of Britain, must be ascribed also the honour of being the birthplace of one of the two inventions which have done more than anything else to aid in the spread of civilisation and commerce. Hulls was born at Aston Magna in 1699. By occupation he was a clock repairer, a precarious trade at best. The difficulties he had to encounter through lack of means were very great, but he persevered, and a patron at last appeared in the person of a Mr. Freeman, of Batsford Park, near Chipping Campden, who supplied him with about £160 to develop and patent his invention. This enabled Hulls to proceed to London, and he petitioned Queen Caroline, as Guardian of the Realm in the absence of her Consort George II. at Hanover, for Letters Patent for the invention, which was accordingly granted to him December 21, 1736, provided he enrolled in Chancery within the following three months a specification describing his invention.* The patent read as follows:

"Whereas our Trusty and Well Beloved Jonathan Hulls hath by his petition humbly represented unto Our most dearly beloved Consort the Queen. . . . That he hath with much Labour and Study, and at Great Expense Invented and Formed a machine for carrying Ships and Vessels out of or into any Harbour, &c., which the Petitioner apprehends may be of great service to our Royal Navy and Merchant Ships, and to Boats and other Vessels, of which Machine the Petitioner hath made oath that he is the sole inventor, as by affidavit to his said petition annexed.

"Know ye therefore that we of our special grace, have given and granted to the said Jonathan Hulls our special

* Mr. J. H. Hulls' lecture at the Institute of Marine Engineers on "The Introduction of Steam Navigation," February 26, 1906.

license, full power, sole privilege and authority during the term of fourteen years, and he shall lawfully make use of the same for carrying ships and other vessels out to sea, or into any harbour or river.

"In witness whereof we have caused these our letters to be made patent.

"(Witness) CAROLINE,
"Queen of Great Britain.

"Given by right of Privy Seal at Westminster this 21st day of December 1736."*

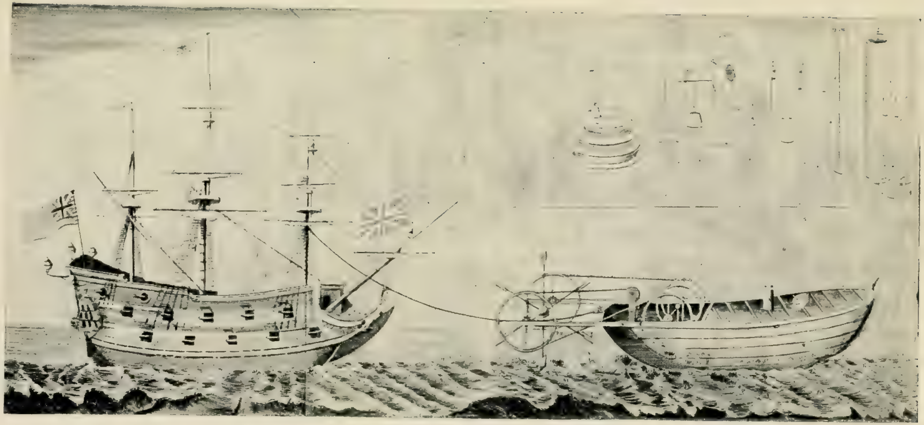
Mr. P. C. Rushen, in referring to the experiment, writes:

"About this time it may be presumed that Jonathan set about constructing a vessel in accordance with his plans, and for this purpose he had the help of the Eagle Foundry at Birmingham, to which he forwarded rough model plans and sketches to aid in founding and forging the various parts. Until quite recent years these relics were existent, but on the sale and demolition of the foundry they seem to have been destroyed.

"The new vessel was tried on the Avon, but tradition says it was a failure, by reason of the inventor not providing the proper means to communicate the power to the paddle. That the experiment was a failure seems evident from the fact that nothing more was heard of the boat, but for the given reason is very improbable, because the very ingenious means the inventor describes, although perhaps not quite practical on a large scale, are not palpably unworkable for a small experimental boat. Even if these means were a failure, it would be ridiculous to suppose that a clever mechanic such as Hulls shows himself to be in his pamphlet would be at a loss for some expedient.

"The more probable reason of Hulls' failure was the

* From copy of patent in possession of Mr. J. H. Hulls.



Jonathan Hulls' Paddle Steamer, 1737.

p. 14

want of financial support, that previously accorded him being perhaps withdrawn on the first hitch in the experiments, or for some other reason, this so disheartening him that he relinquished the idea. While Hulls had been at work on his project, he had worn a brown paper cap, as usual with mechanics at that time, and this fact was taken advantage of in a scathing doggerel, which was circulated upon his failure, and which ran:

> "Jonathan Hull
> With his paper skull;
> Tried to make a Machine
> To go against wind and tide,
> But he, like an ass,
> Couldn't bring it to pass
> So at last was ashamed to be seen." *

The engine which Hulls used was an adaptation of Newcomen's. He published a lengthy description of his boat, in which he states that, in his opinion, it would not be practicable to place his machine on anything but a tow-boat, as it would take up too much room to allow of other goods being carried on the same vessel, and it could "not be used in a storm, or when the waves are very raging." Hulls died in London destitute, and the world inherited his ideas. Steam tow-boats are now found all over the world, and the despised stern-wheeler of his day was the forerunner of the great stern-wheelers of the Mississippi.

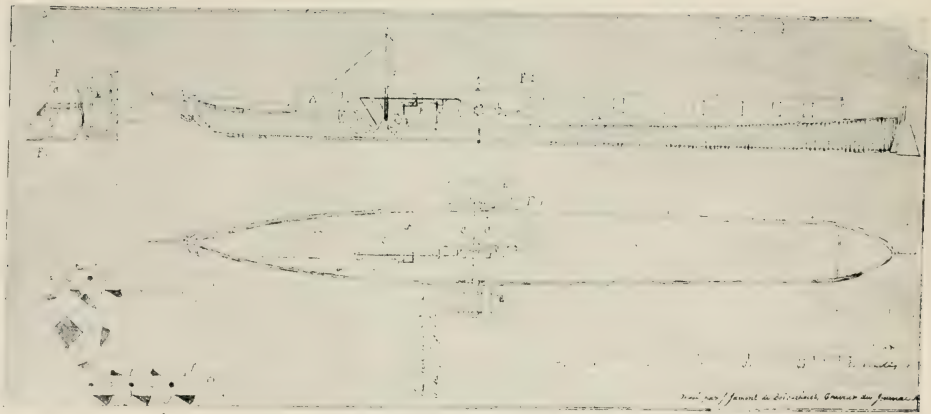
Another person who took up the subject seriously was a Frenchman, Jouffroy d'Abbans, better known perhaps as Claude François Dorothée, Marquis de Jouffroy. His invention was known as the Pyroscaphe. It was claimed for him by the Marquis de Bausset-Roquefort that "he was the first who carried out in practice a scheme for

* P. C. Rushen's "History and Antiquities of Chipping Campden in the County of Gloucester," 1899.

navigation by steam, his successful experiments on the Saône at Lyons in 1783 being attested by official documents, and by the evidence of thousands of spectators. The glory of the invention of the means of using steam-power in navigation belongs therefore to France, as is clearly shown by the archives of the town of Lyons."

The Marquis de Jouffroy was born at Roche-sur-Rognon in 1751. A duel fought while he was page to the Dauphin caused his exile to Provence, where he studied the methods by which the ancient rowing galleys were propelled. He returned to Paris in 1775 and conceived the idea of inventing some form of steamboat while looking at the Chaillot fire-pump which Périer * had erected a short time previously. He communicated his project to Périer, who made some fruitless experiments and declared the idea impossible. Jouffroy, however, persevered, and in 1776 had constructed a machine which he adapted for use on a boat. "His first pyroscaphe was 13 m. long, and 1 m. 95 c. wide. The 'swimming' apparatus consisted of rods 2 m. 66 c. in length suspended on either side well forward and carrying at their extremity frames fitted with hinged flaps with a dip of 50 c. The frames were capable of describing an arc of 2 m. 66 c. (8 feet) radius and of 1 m. (3 feet) in length, and were drawn forward at the end of the stroke by a counterweight. A single-acting engine by Watt, installed in the middle of the boat, set in action these hinged flaps. The construction of this apparatus in a locality where it was impossible to obtain a cast and bored cylinder was a work of genius, courage, and patience. Despite its imperfections it was superior to anything attempted up to that time in navigation. The boat worked on the Doubs at Baume-les-Dames between Montbéliard and Besançon during the months of June and July." This system, since called the

* The name is spelt "Perrier" by some writers.



THE MARQUIS DE JOUFFROY'S STEAMBOAT. 1783.

p. 16

"Palmipède," imitated the movements of aquatic birds, and was the only one that could be applied to the steam-engine as then known. It was, however, useless for moving large masses or for working against the current. "Jouffroy saw the defects caused by the fact that the rapidity of the boat's motion prevented the hinged flaps from reopening after the forward stroke, especially when the pyroscaphe was moving upsteam or against the tide. Hence the engine only acted at intervals instead of keeping up a sustained movement. But Jouffroy substituted paddle-wheels for the hinged flaps (*volets à charnière*) and devised a new machine in which the action of the steam was made continuous by means of two bronze cylinders, the top placed lengthwise with the run of the ship, making with the horizon an angle of about 50 degrees. The bottoms of the cylinders were encased in a metal box containing a sliding tile which opened and shut, alternately giving a passage to the steam and the intake of water in each cylinder.

"By July 1, 1783, Jouffroy had constructed a second boat which was launched at Lyons. Its dimensions were considerable, the length attaining 46 m. and the breadth 4 m. 50 c. The wheels were 4 m. diameter, the paddles 1 m. 95 c., dipping 65 c. The draught of water of the vessel was 95 c. The total weight was 327 milliers, of which 27 were for the vessel and 300 for the freight. This enormous vessel voyaged against the tide of the Saône from Lyons to L'île Barbe in the presence of the Commission de Savants and thousands of spectators, as officially recorded in the archives of the Municipality of Lyons." Arago says this vessel continued to navigate the Saône for sixteen months.*

Jouffroy now thought of starting a company to run

* Paper read by the Marquis de Bausset-Roquefort before the Lyons Literary Society in 1864, and preserved at the Mazarin Library (Academy of Sciences), Paris.

boats on the new system, and applied to the Government for the necessary permission. The question was submitted to the Academy of Sciences, who appointed a Commission to inquire into the matter, but among the members of the Commission was the unsuccessful Perier, whose opposition resulted in the Academy concluding that the experiments at Lyons were not decisive. The Marquis had not the means to continue building steamboats and, profoundly discouraged, he abandoned the rôle of inventor. He had already been subjected to much ridicule, and it was generally agreed that he must be mad to think of "making fire and water agree"; he was even nicknamed "Pump Jouffroy." He witnessed the experiments of Fulton in France, but did not think of claiming the merit of his discovery until 1816, when he issued a publication entitled "Steamboats." The same year he took out a patent, formed a company, and on August 20 launched a steamboat at Bercy, but the venture did not come up to the expectations of the shareholders, and this was his last effort. Jouffroy died of cholera at the Hôpital des Invalides in 1832. Arago, the historian, says that his claims to be the first inventor of the steamboat have been established, and, according to Larousse's "Dictionnaire universel du XIX^{e} siècle," Fulton himself openly acknowledged them in the United States law courts.

CHAPTER II

AMERICAN PIONEERS IN STEAM NAVIGATION

TOWARDS the end of the eighteenth century American inventors turned their attention to the problem of navigation by steam, and to one of them, Robert Fulton, the credit of having invented the steamboat has usually been given. Livingston's "Historical Account of the Application of Steam for the Propelling of Boats" has been accepted as an authority on the subject, but as he was Fulton's friend and backer, and Fulton married into the Livingston family, there is reason to question the absolute accuracy of the circumstantial story told by this most eloquent special pleader, though there is some excuse for his partiality. A little investigation makes it apparent that Fulton was not the first American to design a successful steamboat, nor even the first to make the running of steamboats a satisfactory speculation.

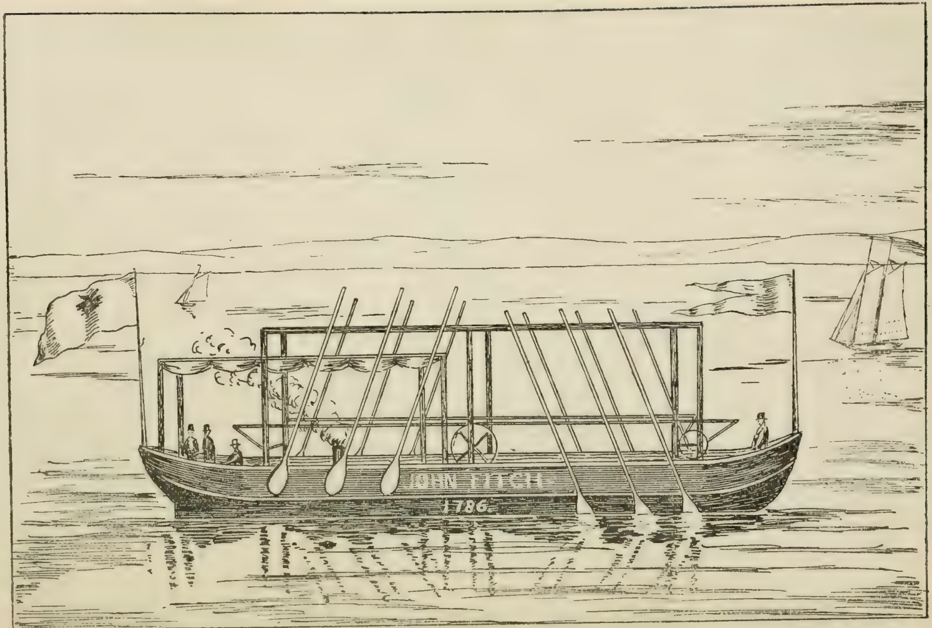
In 1909 a Mr. John Moray of West Virginia presented a petition to Congress in which he asked for the official recognition of James Rumsay as the inventor of the steamboat, and the perpetuation of his memory by the placing of an appropriate bust in the Statuary Hall at the Capitol. According to the petition "The deed-books of

Berkeley County, Va., for the year 1782 record the fact that James Rumsay, a native of Maryland, who was a millwright and Revolutionary soldier, purchased a farm, and soon after a pond, for experimental purposes in the line of his calling. On that pond, as the results of many experiments in steam and hydrostatics by James Rumsay, the wonderful discovery of the principle of steam navigation took place. Thoroughly satisfied by continuous experiments that the newly discovered principle would become of immense value in the world, Rumsay contracted with his brother-in-law, Joseph Barnes, for the building of a boat for steam purposes at St. John's Run, on the Potomac River. The resulting steamboat was publicly exhibited at Shepherdstown, Va., on the Potomac, on December 3 and 11, 1787. The great success and useful character of Rumsay's steamboat were established by sworn testimony of many notable witnesses, including General Horatio Gates, conqueror of Burgoyne, and by a multitude of astonished and delighted spectators. This practically successful trial took place twenty years before the Hudson River trial in 1807, and the speed of Rumsay's boat was fully equal to that of the *Clermont* in its initial trip to Albany—four miles an hour—without sails, paddles, and the complexities of the Hudson River boat."

Rumsay afterwards launched on the Potomac a boat propelled by a steam-engine and machinery, both of which were of his own construction. His method of propelling the boat was to force out a stream of water at the stern, a system known as the "Jet," which has never commended itself to engineers in general, owing to the friction caused in the pipes by the water rushing through them. A trial trip, in December 1787, was successfully made in the presence of a great number of spectators, and resulted in Rumsay being granted the right to navigate the streams of New York, Maryland, and Virginia. His scheme was

taken up by an organisation formed in Philadelphia for that purpose, and known as the Rumsay Society. Benjamin Franklin was among its members. Rumsay also visited England and the Continent, and obtained patents for his invention in Great Britain, France, and Holland, but he did not live long enough to develop his schemes. He made a successful trip on the Thames in 1792, and died in London the same year.

His great rival was John Fitch, who, in 1785, conceived the idea of using steam-power for land carriages and afterwards for vessels. His first model of a steamer carried large wheels at the sides, but these were found to labour too much in the water, and in his experiments in July 1786 upon a skiff with a steam-engine having a three-inch cylinder, the wheels were replaced by paddles or oars supported by a framework above the vessel. Convinced of the success which must ultimately attend the use of steam-power, he petitioned Congress and the State Legislature for a grant of money, but without avail. As a result of his efforts to interest "the leading scientific and public men of that day, everywhere and at all times," and his bold advocacy of the adoption of steam for purposes of navigation, he was generally considered insane. But in 1786 he succeeded in persuading the State of New Jersey to grant him for fourteen years the sole and exclusive right to navigate its waters by steam, and this example was followed in 1787 by the States of New York, Delaware, Pennsylvania, and Virginia. He had earned some money by map-making, and now formed a company and built a boat of 60 tons. She was 45 feet long with a beam of 12 feet, had six oars or paddles on each side, and carried an engine with a 12-inch cylinder. She made a successful trial trip at Philadelphia in 1787. A still larger boat followed in 1788, and another in 1790. The latter demonstrated "with their increased speed and facility the value of Fitch's invention," and the last was run during the



John Fitch's Oared Paddle boat, 1786

summer as a passenger boat between Philadelphia and Burlington at a speed of about eight miles an hour. She appears, from an illustration in Appleton's "Cyclopædia of American Biography," to have had three large paddles at the stern held in place by a projecting frame, a cross-beam at the extreme end of the frame supporting the rudder, which was placed a little distance behind the paddles. Consequent upon the Virginia patent which gave him the exclusive right of navigating "the Ohio River and its tributaries" he now designed a boat called the *Perseverance*, for freight and passengers on the Mississippi. But as, owing to a storm, she could not be got ready in time, the default clause in the patent became operative. Fitch's associates now left him and his own resources were at an end, and after one or two other misfortunes he went to France in 1793. Needless to say, that country was in no mood then to entertain the idea of building steamboats. Finding no one ready to listen to his schemes, Fitch departed for London, having deposited his plans and specifications with the American Consul at Lorient.

A rather curious thing then happened.

"During this absence his (Fitch's) drawings and papers were loaned by the Consul to Robert Fulton, then in Paris, in whose possession they were for several months."* Until now, it must be remembered, Fulton had scarcely been heard of in connection with steamboats.

Meantime the ill-starred Fitch, unable to gain a hearing in England either, worked his passage back to America as a common sailor. In 1796, still determined to convince the public of the need for steamboats, he obtained a ship's yawl, and fitted her with an engine and screw-propeller. With these he experimented in New York and, as usual, no one took any interest in the boat except the proprietor. In 1798 he made and tried upon a small stream near Bardstown a steamboat model measuring three feet in

* Appleton's "Cyclopædia."

length, but a few weeks later he committed suicide by taking poison. His "Journal" contains the following passage: "The day will come when some more powerful man will get fame and riches from *my* invention, but nobody will believe that poor John Fitch can do anything worthy of attention."

About twenty years later Fitch's merits as an inventor were recognised by a Committee of the New York Legislature, which reported that "the steamboats built by Livingston and Fulton were in substance the invention patented to John Fitch in 1791, and Fitch during the term of his patent had the exclusive right to use the same in the United States."

Other inventors were at work. Fulton was in France thinking over the Fitch drawings which had been left there in 1793, trying a submarine boat on the Seine, and in 1801 making a variety of experiments under the auspices of the French Government.

In America, one Samuel Morey, in 1790, built a strange boat with a paddle-wheel in the prow, constructed a steam-engine for her, and presently was voyaging on the Connecticut River at the break-neck speed of four miles an hour. A few years later he had another boat ready which could do five miles an hour, this boat having a wheel at the stern, and by request he took Chancellor R. Livingston and others for a trip in New York waters. The Chancellor, who had made a trip in Morey's first boat at Orford, perceived two things, first, that the speed ought to be increased, and, second, that there was money in steamboats. He promised Morey 100,000 dollars, it is believed, if he could run a boat at eight miles an hour, and offered him 7000 dollars for a patent for the North River as far as Amboy for what had already been accomplished. The latter offer was not accepted. Morey in 1795 took out a patent for a steam-engine, in which the power was to be applied by crank motion, to propel boats of any size. Two

years later he built a steamer which he placed on the Delaware, and propelled it by means of two paddle-wheels, one on either side. These wheels gave better results than any method which had yet been tried.

When, a little later, Livingston went to France and became associated with Fulton as the financier of his enterprises, it is probable that the knowledge the former had gained of Morey's work and Roosevelt's experiments, and the latter of Fitch's designs, proved extremely useful to both of them. Nicholas J. Roosevelt had attracted some attention by building a small wooden boat across which was an axle projecting over the sides, and carrying paddles, the contrivance being made to revolve by a light cord wound round the middle of the machine and attached to hickory and whalebone springs. In 1798 he recommended to Livingston a vertical wheel, and the Chancellor replied, " Vertical wheels are out of the question." As late as 1802 Fulton favoured chains and floats, and it was not until after Livingston had communicated Roosevelt's plan to him that they applied vertical wheels on Roosevelt's system to their boat on the Seine.

About this time also Livingston was engaged with John Stevens, his brother-in-law, and Nicholas J. Roosevelt on the construction of a steamboat to be used on the Hudson, the New York State Legislature having granted the necessary monopoly. The State required that the boat should attain a speed of three miles an hour, but this was not achieved. Livingston was appointed Minister to France in 1801, and was thus cut off from his two partners and brought into communication with Fulton. Another version is that the boat made three miles an hour, and that the State stipulated for four miles an hour.

Robert Fulton, asserted to be an Irishman by descent, was born in Pennsylvania in 1765. When a boy he had witnessed the experiments made on the Delaware by John Fitch, but the problems of steam navigation were only a

few of those which occupied his versatile genius. He came to England in 1786, and in 1794 invented a marble-sawing machine, a flax-spinning machine, a machine for ropemaking and a mechanical dredger. In 1795 he published a treatise on canal navigation in which he suggested a number of improvements in lock construction.

In 1797 he went to France and was for some time occupied in designing and experimenting with submarine boats. He suggested to the French Government that his submarine would be useful in destroying the British Fleet. The Directory would have nothing to do with his plans, but when Napoleon became First Consul a Commission was appointed to investigate and report upon them. Beyond agitating the British Government for some time, however, while he experimented with torpedoes designed to destroy their fleet, and trying unsuccessfully to sell his invention to the French Government, nothing was accomplished. He came over to England in 1804 prepared to sell his invention to the British Government. From one point of view Fulton appears as the inventor of a horrible engine of destruction, ready to dispose of it to any country which would buy at a remunerative price.

But there is another aspect of Fulton, and this is exhibited by his enthusiastic biographer Cadwallader D. Colden. According to this gentleman, Fulton took no interest "in the then existing contest" between England and France. England and France were to him possible torpedo buyers and their fleets possible torpedo victims. But his ideals included universal free trade and the liberty of the seas, and he looked upon the annihilation of naval armaments as a step in the right direction, as it would destroy what he called the war system of Europe. If this could be effected nations would engage in education, science, and a rivalry of peaceful arts.

Fulton has been called a prophet and a statesman; but the doctrine that warfare will be ended by elaborating a

more deadly means of destruction than has hitherto been known, coupled with the implied assertion that each invention is the last word in destruction, suggests at once conspicuous limitations in prophecy and statecraft. He never thought of torpedo destroyers.

In 1793 Fulton corresponded with Lord Stanhope on the subject of steam navigation. Lord Stanhope was fully aware that invention was knocking at the door, for in a letter to Wilberforce he says: "This country is vulnerable in so many ways, the picture is horrid. . . . I know, and in a few weeks I shall prove, that ships of any size may be navigated so as to go without wind and even directly against both wind and waves. . . . The most important consequence which I draw from this stupendous fact is this. It will shortly render all the navies of the world (I mean military navies) no better than lumber. For what can ships do that are dependent on wind and weather against fleets that are wholly independent of either? Therefore the boasted superiority of the British Navy is no more. We must have a new one. The French and other nations will for the same reasons have the same."

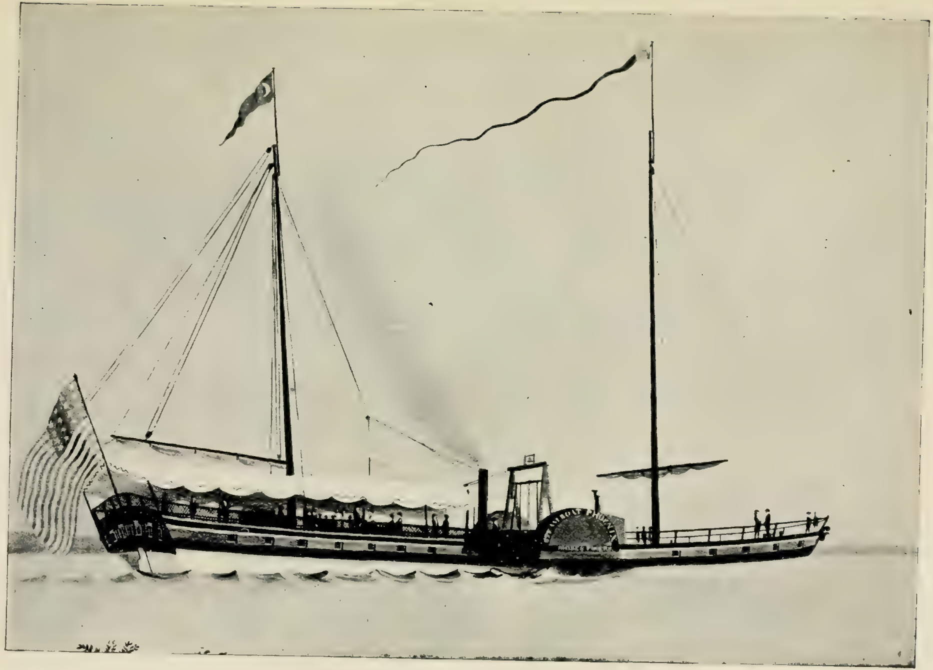
He was himself an experimenter, and had been endeavouring to propel a boat by means of an appliance resembling a mechanical duck's foot. The plans which Fulton submitted to him show a boat with an immense bow or spring fastened to a stumpy mast amidships, operating on a large paddle for which the rail at the extreme end of a raking stern acted as a fulcrum; a second plan shows the boat with a three-paddle revolving wheel at the side.

When Livingston went to France in 1801, an enthusiast for steam navigation, and, what was more important, an enthusiast of considerable means, Fulton, whom he there met and financed, was stimulated to fresh exertions. By 1803 a boat to their joint account was built, 70 feet long and 8 feet beam. With this it was

proposed to experiment on the Seine. But the machinery, which is said to have been made by Périer, who opposed the Marquis de Jouffroy, was too heavy for the hull. The night before the trial trip was to be made was stormy: the boat broke in half and sank. Notwithstanding this blow to their hopes the partners proceeded with their attempts. The machinery was recovered and found to be practically uninjured, and the hull was rebuilt more strongly. The trial trip took place in August 1803, when the boat made four and a half miles an hour. This was a very moderate speed and was disappointing to all concerned. Nevertheless a voyage by a steam-ship had been made, and it is strange that very little notice was taken of the event in France. Livingston wrote home to America and described it enthusiastically, and he and Fulton determined to build a boat for American waters as soon as Fulton should return thither.

Shortly after this experiment Fulton visited Symington, who, as will be seen in the next chapter, had succeeded, with the assistance of Lord Dundas, in starting a little steamer, the *Charlotte Dundas*, on the Clyde as early as 1802. While this boat was being used on the Forth and Clyde Canal, Fulton introduced himself to Symington, whom he accompanied on a trip in the boat, the voyage being made solely on Fulton's account.* The American took copious notes in a memorandum book and, to quote from Symington's narrative, " after putting several pointed questions respecting the general construction and effect of the machine, which I answered in a most explicit manner, he jotted down particularly everything then described, with his own remarks upon the boat while moving with him on board along the canal; but he seems to have been altogether forgetful of this, as notwithstanding his fair promises, I never heard anything more of him until reading in a newspaper an account of his death."

* Knight's "Cyclopædia."



John Stevens' "Phœnix," 1807.

p. 28

Meantime Stevens, left to himself, had, in 1804, built a vessel propelled by twin screws which navigated the Hudson River. This vessel was remarkable in many ways. The boiler was tubular, and the screw was almost identical with the short four-threaded helix which many years afterwards was generally adopted. It is interesting to note that the screw propeller was tried so early, for it is generally believed that it was not used at all until many years after the introduction of paddles. The engine and boiler of Stevens' boat are preserved at the Stevens Institute at Hoboken. After his death his son tried the engine and boiler in a boat, which, in the presence of a committee of the American Institute of New York, attained a speed of about nine miles an hour. Although the screw proved its suitability for propulsion, its superiority was not acknowledged, and for many years afterwards marine engineers confined their attention to the improvement of paddle-wheels and the engines for driving them. In 1807, with the assistance of his son Robert, Stevens built the paddle-wheel steamer *Phœnix*, which plied for six years on the Delaware.

Dr. James Renwick of Columbia said that "the Stevenses were but a few days later" than Fulton "in moving a boat with the required velocity," and that "being shut out of the waters of New York by the monopoly of Livingston and Fulton, Stevens conceived the bold design of conveying his boat, the *Phœnix*, to the Delaware by sea, and this boat, which was so near reaping the honour of first success, was the first to navigate the ocean by the power of steam." The piston-rod of the *Phœnix* was guided by slides instead of the parallel motion of the Watt engine, and the cylinder rested on the condenser. A point in which the superiority of the *Phœnix* over the *Clermont* was shown, was that the paddle-wheel of the *Phœnix* had a guard beam, which the *Clermont* lacked. The *Phœnix* was taken to Philadelphia by

sea by Robert Livingston Stevens, son of Robert Stevens. He was accompanied on this voyage by Moses Rogers, to whom the title of "Pioneer Steam Nàvigator" has been given by American historians, partly on account of this voyage and partly because he was on board the auxiliary sailing ship *Savannah* on her memorable voyage to Europe.*

In 1806 Fulton returned to America, having ordered an engine to be made by Messrs. Boulton and Watt at Birmingham. He did not tell them what he proposed to do with it, but it was the engine for the first steamboat constructed by him for American voyages—the famous *Clermont*. After this engine was delivered in New York it remained in the Customs while Brownne, a shipbuilder, constructed the hull. In 1807 the boat made her first trip on the Hudson.

The original dimensions of the *Clermont* have been variously stated, the discrepancies being probably due to the alterations to which the vessel was subjected, and also to methods of measurement. From a letter which Fulton wrote it appears that the boat was 150 feet long and 13 feet wide, drawing 2 feet of water.† This was no doubt the over-all figure, as other data give slightly less lengths which would be on the water-line, or the inside measure ments between stem and stern, both of which raked.

Messrs. Millard and Kirby, of New York, who made most exhaustive researches into the history of the *Clermont* with a view to the reproduction of that historical vessel at the centenary celebration at New York in September 1909, state that when Fulton worked out his displacement and wetted surface and resistance, his results corresponded with a boat of the dimensions just given, and no other figures could have given those results.

On November 20, 1807, Fulton wrote to Livingston

* See p. 122.

† Reprinted in the *Nautical Gazette,* New York, August 22, 1907.

that the boat was so weak that she must have additional knees and timbers, new side timbers, deck beams and deck, new windows, and cabins altered; that she, perhaps, must be sheathed, her boiler taken out and a new one put in, her axles forged and ironwork strengthened. With all this work the saving of the hull would be of little consequence, particularly as many of her knees, bolts, timbers and planks could be used in the construction of a new boat. His opinion, therefore, was that a new hull should be built with knees and floor timbers of oak, bottom planks of two-inch oak and side planks of two-inch oak for 3 feet high. "She is to be 16 feet wide, 150 feet long; this will make her near twice as stiff as at present and enable us to carry a much greater quantity of sail. The 4 feet additional width will require 1146 lb. additional purchase at the engine, moving 2 feet a second or 15 double strokes a minute; this will be gained by raising the steam 5 lb. to the inch, as 24 inches the diameter of the cylinder gives 570 round inches at 3 lb. to the inch—1710 lb. purchase gained. To accomplish this work a good boiler and a commodious boat running our present speed, of a voyage in 30 hours, I think better and more productive to us than to gain one mile on the present boat."

The first *Clermont* had a depth of hold of 7 feet. She had masts and sails but no wheel enclosures, no bulwarks, no berths in the cabin, and no covering over the boilers; this work being done, according to Fulton's letter of August 29, 1807, after his return from the first trip. When she was altered on account of instability, in the winter 1807–8, she was widened to 16 feet on the bottom and 18 feet at the deck, which made her much stiffer. It was then that her poop was built up and various other improvements made.

Her fly-wheels were outside the hull, placed forward of the paddles, and revolved the same way, and it is

related that on a subsequent voyage one of the paddle-wheels becoming disabled, paddles were affixed to the fly-wheel and the voyage resumed.

The *American Citizen* of August 17, 1807, announced that: "Mr. Fulton's ingenious Steamboat, invented with a View to the Navigation of The Mississippi from New Orleans upwards, Sails to-day from the North River near The State Prison to Albany, the Velosity of the Steamboat is calculated at four miles an hour; it is said that it will make a progress of two against The Current of The Mississippi, and if so it will certainly be a very valuable acquisition to the Commerce of the Western States."

An immense crowd assembled to witness the fiasco which was expected to mark the first experimental voyage of "Fulton's Folly," and jeered Fulton and his steamer unmercifully. But when the vessel moved into midstream under the power of her own engines, the crowd cheered as energetically as only a crowd can when it has been agreeably surprised and the appeal of facts to its chivalry is irresistible.

"Dense volumes of smoke began to pour forth from the smokestack. The boiler began to hiss. At one o'clock the hawser was drawn in, the throttle opened, and to the accompaniment of the stertorous exhaust, the uncovered sidewheels began to quiver, then slowly to revolve. A hush fell on the spectators. Fulton's own hand at the helm turned the bow. The *Clermont* moved out into the stream, the steam connections hissing at the joints, the crude machinery thumping and groaning, the wheels splashing, and the smokestack belching like a volcano. . . . One honest countryman, after beholding the unaccountable object from the shore, ran home and told his wife he had 'seen the devil on his way to Albany in a sawmill.'"* A passenger, recording the voyage, says a miller boarded the *Clermont* at Haverstraw and said he

* New York *Evening Sun*, July 1909.

"did not know about a mill going up stream and came to inquire about it."

The boat itself was wedge-shaped at bow and stern, which were cut sharp to an angle of 60 degrees. She was almost wall-sided. She was flat-bottomed and keelless, leeway being prevented by two steering boards. Her tiller was at the back end of the after cabin so that it was difficult for the steersman to see ahead. The paddle-wheels, 15 feet in diameter, being uncovered, splashed tremendously, and drenched the passengers. A paddle-wheel had to be disconnected when it was desired to turn the vessel round.

The *Clermont* reached Chancellor Livingston's residence at Clermont, 110 miles from New York, in 24 hours, against the wind, the average speed being 4·6 miles an hour. The running time for the whole journey to Albany of 150 miles was 32 hours, or nearly five miles an hour; the return trip was made in 32 hours, running time, the sails not being used on either occasion. An eye-witness as she passed up the river thus describes her:

"It was in the early autumn of the year 1807 that a knot of villagers was gathered on a high bluff, just opposite Poughkeepsie, on the west bank of the Hudson, attracted by the appearance of a strange-looking craft, which was slowly making its way up the river. Some imagined it to be a sea monster, whilst others did not hesitate to express their belief that it was a sign of the approaching judgment. What seemed strange in the vessel was the substitution of a lofty and strange black smoke-pipe rising from the deck, instead of the gracefully tapered masts that commonly stood on the vessels navigating the stream, and, in place of the spars and rigging, the curious play of the working beam and piston, and the slow turning and splashing of the huge and naked paddle-wheels, met their astonished gaze. The dense

clouds of smoke, as they rose wave upon wave, added still more to the wonder of the rustics. This strange-looking craft was the *Clermont* on her trial trip to Albany; and, of the little knot of villagers above mentioned, the writer, then a boy in his eighth year, with his parents, formed a part, and I well remember the scene, one so well fitted to impress a lasting picture upon the mind of a child accustomed to watch the vessels that passed up and down the river. On her return trip, the curiosity she excited was scarcely less intense—the whole country talked of nothing but the sea monster, belching forth fire and smoke.

"The fishermen became terrified and rowed homeward, and they saw nothing but destruction devastating their fishing grounds; whilst the wreaths of black vapours, and rushing noise of the paddle-wheels, foaming with the stirred-up waters, produced great excitement amongst the boatmen, until it was more intelligent than before; for the character of that curious boat, and the nature of the enterprise she was pioneering had been ascertained."

According to Colden, those who saw the *Clermont* at night described her as "a monster moving on the water, defying the winds and the tide, and breathing flames and smoke." She had, he proceeds to say, "the most terrific appearance from other vessels which were navigating the river when she was making her passage. The first steam-boats, as others yet do, used dry pine-wood for fuel, which sends forth a column of ignited vapour, many feet above the flue, and whenever the fire is stirred a galaxy of sparks fly off, which in the night have an airy, brilliant, and beautiful appearance. This uncommon light first attracted the attention of crews of other vessels. Notwithstanding the wind and tide were adverse to its approach, they saw with astonishment that it was rapidly coming towards them; and when it came so near that the noise of the machinery and the paddles were heard, the crews in some

instances shrunk beneath their decks from the terrific sight; and others left their vessels to go on shore; while others again prostrated themselves, and besought Providence to protect them from the approach of the horrible monster which was marching on the tides, and lighting its path by the fires which it vomited."

After the improvements had been made in the *Clermont* she entered in the spring of 1809 upon the regular work for which she was intended—the day service between New York and Albany.

The guards and paddle-boxes, which were mere temporary structures, were made substantial and permanent, and the cabins were rearranged and refitted in the most beautiful manner. The *Clermont*, said Professor Renwick, "thus converted into a floating palace, gay with ornamental painting, gilding, and polished woods, commenced her course of passages for the second year in the month of April." *

When rebuilt she was christened the *North River* and maintained the service alone until October, when a second Fulton boat, the *Car of Neptune*, was launched. She was a larger boat, and ran continuously until 1817, and the other vessels which were added to the little fleet also proved successful.

The complete list of Fulton's steamboats would include also the *Rariton* (1809), *New Orleans* (1811), *Paragon*, *Firefly*, a Jersey ferryboat, and *Camden* (1812), *Washington* and a York ferryboat (1813), *Richmond*, a Nassau ferryboat, *Fulton*, *Vesuvius*, and *Demologos*, a warship (1814), *Aetna*, *Buffalo*, and *Mute* (1815), *Olive Branch*, *Empress of Russia*, and *Chancellor Livingston* (1816).

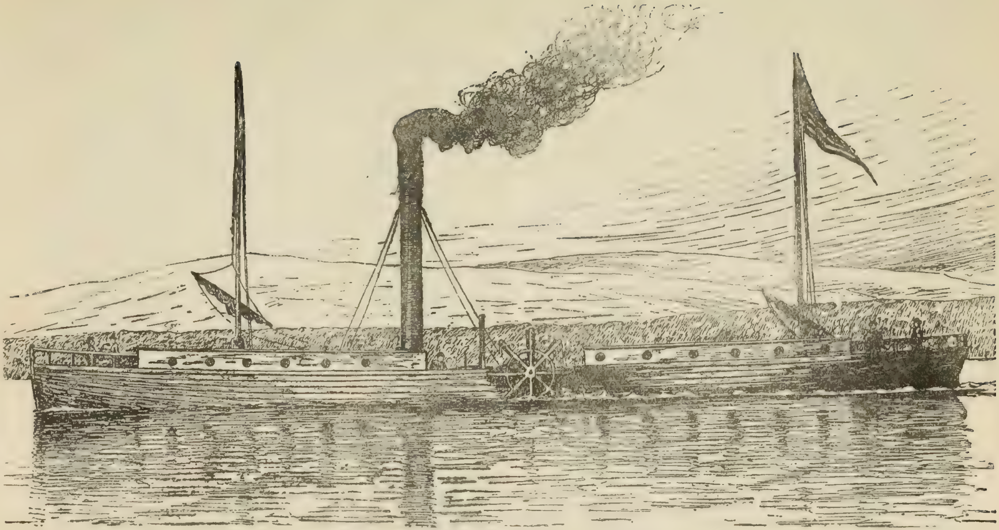
Fulton and Livingston's enterprise was a financial success almost from the first, and naturally others thought to share in it; as they could not join the pioneers they

* The "Master, Mate, and Pilot."

determined to rival them. One of the chief of these was a Captain Elihu S. Bunker, who maintained a line of sailing sloops between Hudson City and New York. The steamers were taking the wind out of his sails in more senses than one, and not liking the prospect of being becalmed, financially, he determined to go in for steam. A syndicate of capitalists of Albany backed him. The fact that Livingston and Fulton had been already granted an absolute monopoly for navigating the waters of the State of New York by steam deterred them not a whit. They ordered two boats, to be about the size of the *Clermont*, and called them the *Hope* and *Perseverance.* They were each 149 feet in length, 25 feet beam inside the paddles, and had a depth of 7 feet 7 inches.

Legal proceedings quickly followed, Livingston and Fulton having their work cut out to defend their monopoly. How like these boats were to the Fulton boats is evident from the affidavit of Charles Brownne, the builder of the *Clermont.* He says that he has "examined the steamboats *Hope* and *Perseverance* and they are not built like any vessels which navigate by wind or oars on any of our waters, or any foreign waters that he knows of. That said steamboats being more than Six the length of their breadth * of beam and flat at bottom are not calculated to navigate with sails only. And that the first boats of such make of the said steamboats which he ever saw or heard of was built by him from drawings and directions given to him by Robert Fulton and constructed to be navigated by steam and wind, and which boats are now known by the name of *North River* and *Car of Neptune* Steamboats: This deponent also saith that the water wheels; the guards round the water wheels, the covering to the water wheels; the steps from the wheel guards to enter the row-boats, space on the guards for wood for the

* *Sic:* probably means "their length was rather more than six times their beam."



Robert Fulton's "Clermont," 1807.

engine, bins or lockers in the wheel guards and necessaries on the fore part of the wheel guards, are exact copies from the Boats built by him for Livingston and Fulton, and such water wheels, wheel guards and conveniences he has never known or heard of to any other kind of boat or vessel. This deponent further saith that in the said Steamboat *Hope* the manner of arranging the rudder with a perpendicular iron bar on its after part, and leading from its wheel ropes, along the sides of the boat to a steering wheel before the Chimney of the Boiler and to a Station above the place of the engineer and fireman, is an exact copy from the boats of Livingston and Fulton. This deponent objected to this mode of steering at the time the said Fulton proposed it, believing it to be impracticable, and he does not know of a like mode of steering to any other kind of vessel. This deponent also says that the mode of placing the main mast far forward, and the mizzen mast so far aft, as to leave a convenient space between the two, which shall not be incommoded by ropes, booms, or yards, and afford room for spreading an awning for the comfort and convenience of passengers is the same exactly in the said *Hope* Steamboat as in the boats built by him for Livingston and Fulton. That this mode of placing masts so far apart, to the best of his knowledge, is not known in any other kind of vessel, and would not answer for a vessel intended to work with wind only, without the aid of steam, but in union with steam has been proved by three years' experience on the *North River* Steamboat to suceeed perfectly well. This deponent further says that the form and make of the said *Hope* and *Perseverance* steamboats, their wheels, wheel guards, manner of steering, mode of placing the masts and rigging, mode of arranging the awning, arrangements of the Cabins and kitchen, suspending their row-boats from the sides instead of from the stern, as is usual, are in his opinion in all these combinations and arrangement, exact copies from the *Car of*

Neptune Steamboat, *and more like her than she is like the* North River *Steamboat* which was first built, and further this deponent saith not." *

The *Hope* and *Perseverance* ran throughout the season of 1811 with passengers and freight, between New York and Albany, and met with as much of the public patronage as did the other boats. The courts, however, decided that Captain Bunker and his supporters were acting illegally, and gave the drastic order that their steamers should be confiscated and handed over to Livingston and Fulton, who did not run them but had them broken up.

Writing in 1838, in regard to his early experiments, to the Secretary of the Treasury at Washington, Captain Bunker described an incident which unfortunately for American steamship records does not stand alone. The Captain was undoubtedly fortunate that matters were no worse.

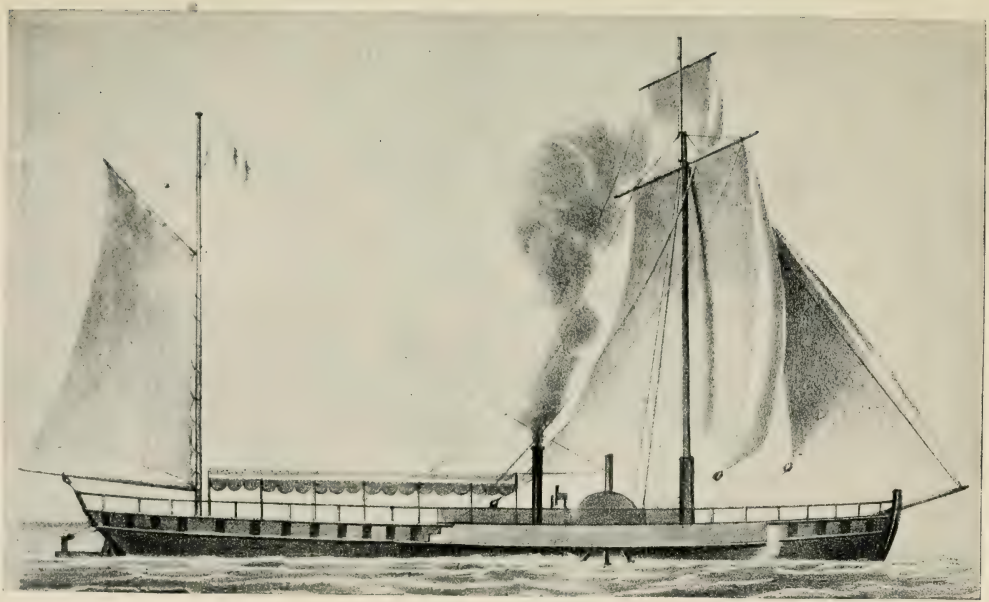
"In 1811," he says, "I had command of the steamboat *Hope* plying between New York and Albany. The engine and boilers were made and put in by Robert McQueen. On the second trip from New York, while Mr. McQueen's foreman had still charge of the works on board (they not having been delivered as completed), this man had a gang of his own men from the shop, and, while proving the machinery, had a man that he was instructing to become engineer of the boat. While on the passage, off Esopus meadows, something appeared to be wrong in the fire-room (which was in charge of a miserable drunken fireman) and the engine moving very slowly. I found on examination, that there was not a drop of water in either of the boilers, and that both of them were red-hot, as well as the flues, and must have been so for at least half an hour. The heat was great enough to melt down five

* "Steamboats on the Hudson," in the "Master, Mate, and Pilot," October 1909.

solder-joints of steam-pipe, which was made of copper. I immediately started the forcing pump myself, not thinking that there could be any danger in the operation; the effect of which was a crackling in the boiler as the water met the hot iron, the sound of which was like that often heard in a blacksmith's shop when water is thrown upon a piece of hot iron. I cannot, therefore, believe for a single moment that explosions are produced, to such a degree as I have before recited, by throwing cold water into a red-hot boiler. In the way above described, I cooled down both of the boilers, during which time neither of them jumped out of its place; nor do I see how it could be possible for such an effect to be produced, having always been of opinion that there could be no other cause for a boiler to burst than the pressure of steam inside, and not gas produced by letting cold water or lukewarm water into it; for I deem it impossible for a red-hot boiler to contain heat enough to explode with any quantity of water that might be suddenly thrown into it. Besides, it must be remembered that the supply-pipes are connected with the bottom of all steam-boilers, or are very near to the bottom; therefore, instead of producing explosion, the forcing of cold or lukewarm water into hot water must have the tendency to cool it. For instance, I have known engineers to keep off their feed as long as they possibly dared, when running with another boat, knowing that as soon as they began to feed, the steam would fall, especially if they could not get a full supply of steam for the engine." *

So far as the Hudson was concerned the decision of the courts crushed Captain Bunker, and frightened off any other possible trespassers on the monopoly. But Bunker had determined to become a steamship owner, and being crowded out of the Hudson he started a line of steamers as near New York City as he could, the Long

* The "Master, Mate, and Pilot," Vol. II. No. 5.



THE "PARAGON." BUILT 1811.

p. 40

Island Sound Line. The first of his vessels he named after his late opponent Fulton. She was built in 1813 and plied for the whole of her first season in 1814 on the Hudson River, as, the United States being then at war with England, it was feared that she would be captured if she ventured up the Sound.

At the time the Fulton boats had to meet Bunker's opposition, the third Fulton steamboat, the *Paragon*, made its first appearance on the river. She was both faster and larger than her predecessors. She was fitted with two masts, one stepped very far forward, and the other very far aft. The foremast carried an immense square foresail with a little square topsail above it, and there was also a large triangular sail carried on the stay from the end of the bowsprit to the cap of the lower mast. The aftermast carried an ordinary trysail or mizzen. The vessel had a large rudder and was steered from amidships, according to a contemporary print.

The following year another Fulton steamer, the *Firefly*, came on the scene. She was a small vessel, only 81 feet in length, and though designed for the lower river service, was used elsewhere as occasion demanded. Fulton by this time was himself planning the placing of steamers on other rivers, and in 1814 the *Richmond* was launched from his designs for the James River in Virginia. The British-American War at this time rendered it unsafe to send her south, and as the *North River*, late *Clermont*, was about worn out by now, the *Richmond* took her place. Fulton seems to have been associated to some extent with Bunker, for the latter's boat, *Fulton*, was designed by Fulton himself. She was a sloop-rigged vessel with a single mast stepped well forward, and made considerable use of sails. She was 134 feet in length and 26 feet beam, and had a large square engine-house that extended rather above the sides of her paddles-boxes. Hitherto all the American steamers had been of the wall-sided, flat-

bottomed type inaugurated by the *Clermont*. The *Fulton* was the first steamer to be constructed with a round bottom like a sailing ship.

Fulton was also interested in steamboats on the Mississippi and other western waters. He and Nicholas Roosevelt were associated in 1809 in this project, and in 1811 the steamer *New Orleans* was built. It was the pioneer boat of the service, and descended the Ohio and Mississippi Rivers from Pittsburg to New Orleans in fourteen days. In 1817 the *Chancellor Livingston* appeared on the Hudson and in her general equipment marked a decided improvement in every respect upon anything that had gone before. She was the finest vessel without exception that Fulton and Livingston ever possessed. Her designer was Henry Eckford, one of the leading naval architects in America. She was, moreover, the biggest steamboat which had been built in the world, as she was of over 500 tons burden. The building of this boat was supervised at first by Fulton himself, but he died before it was completed. The *Chancellor Livingston* was three-masted, and fore-and-aft rigged throughout, and carried in addition a large square sail on the foremast. She had three funnels which were placed forward of the paddle-boxes and between the fore and main masts. Her engines were of the steeple type. She was square-sterned, and not only carried a deck-house, but the roof of the deck-house was extended to form a square deck or gallery, and above this again were a smaller deck-house and a large awning, so that passengers on either deck were amply protected from the weather. The gallery, at the stern, was the same shape as the stern itself. It was supported by stanchions, and carried as far forward as the paddle-boxes. Early pictures of this vessel represent her as having portholes along the sides of the hull abaft the paddles, from which it would appear that in the body of the ship itself there was also passenger accommodation.

She was therefore the first vessel to have three decks devoted to passengers.

The first trip of this boat was made towards the end of March 1817, between New York and Newburgh, the 65 miles being covered in less than nine hours, in only three of which was the tide running with the ship. Coming back she did the distance in eight hours fifteen minutes, for the most part against wind and tide. Her cost complete was 110,000 dollars.

This boat was not allowed to lie idle, and a statement was published in December 1821 that the *Chancellor Livingston* made during the season of that year "170 trips from New York to Albany. Allowing the distance to be 150 miles the aggregate will exceed 25,000 miles, which would more than have carried her round the globe. We presume the *Richmond* has performed the same number of trips, and when it is considered that these boats are generally filled with passengers, some idea may be formed of the extent of travel on the North River."

Already excursions were very popular. The *Chancellor Livingston* took excursionists once a week during July and August as far as Sandy Hook. The same year, 1821, the steamer *Franklin* took passengers to the fishing banks twice weekly, and the *Olive Branch* of the Philadelphia Line gave its patrons what its owners called "a sail around Staten Island and turtle feast," and it was added that "a fine green turtle will be cooked, and a band of music provided," all for one dollar seventy-five cents. Captain Bunker, who had the *Enterprise* built in 1818 at Hartford, Connecticut, brought her into the New York service in 1821, for an excursion starting at half-past four in the morning from the East River for Sands Point. This is one of the earliest records of a steamer built elsewhere coming to New York waters to enter upon the local trade.

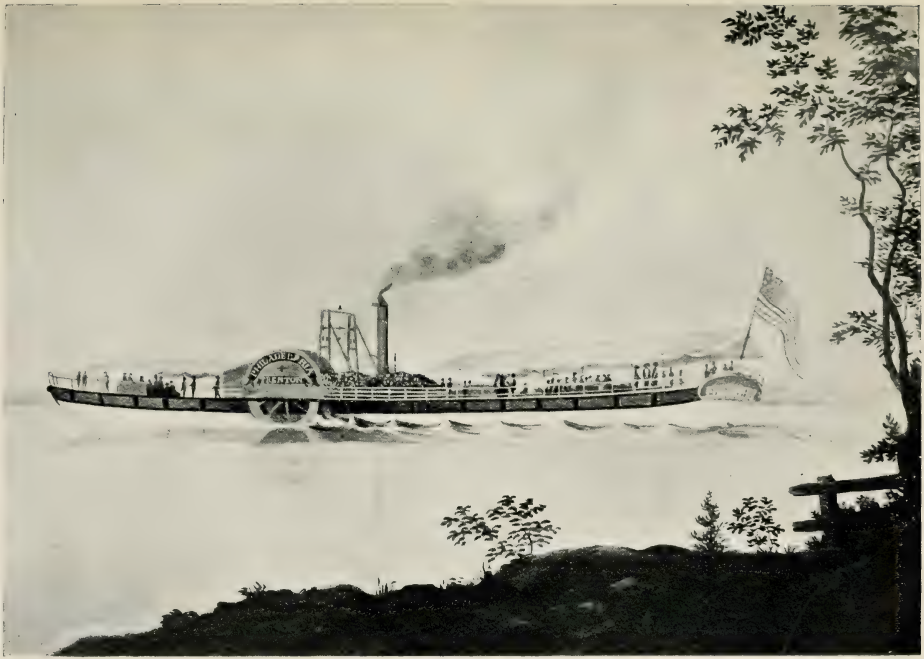
Henry Eckford also planned the steamer *Robert*

Fulton, which in 1822 made the first successful steam voyage from New York to New Orleans, and thence to Havana, in which trade she was afterwards engaged regularly. The *Robert Fulton* then passed into the possession of the Brazilian naval authorities, who turned her into a sailing ship and she became the fastest war-sloop in the Brazilian navy.

The *Firefly* was the first steamer to get round Point Judith, on the Rhode Island shore, and reach Newport from New York. This was May 26, 1817, and the voyage lasted twenty-eight hours. The sailing packets on the route, as usual, resented her incursion, and when the wind was favourable they usually outsailed her. The competition grew so great between the steamer and the sailers that the latter made the typical American sporting proposal not to charge passengers for the voyage between New York and Newport if they did not reach port before the steamer.

Although the size of the American river steamers had been steadily increasing, there had not been a great acceleration in the matter of speed. Even at the time of Fulton's death few, if any, American river steamers exceeded an average of seven miles an hour for the trip.

Robert Livingston Stevens, son of John Stevens, built about that time (1813) the *Philadelphia*, which attained an average speed of eight miles. Speed was a question to which he devoted considerable attention, for he realised its importance, and nearly every vessel he turned out was an improvement upon its predecessor. The inventions and improvements which he introduced inaugurated a new era of steamboat construction. Of the fate which overtook some of these early vessels, it may be noted that the *Clermont* died of premature old age, the *Car of Neptune* was broken up, the *Paragon* went to the bottom, and the *Hope*, the *Perseverance*, the *Firefly*, and the *Richmond* were broken up.



THE "PHILADELPHIA." BUILT 1826.

p. 44

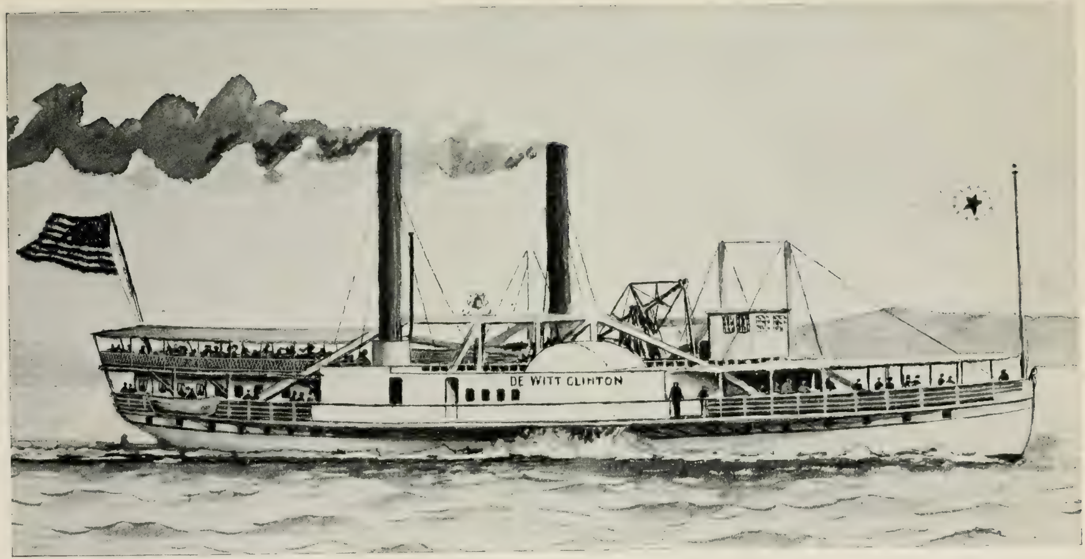
According to evidence given before a Select Committee of the House of Commons in 1817 by Mr. Seth Hunt of Louisiana, there were then ten steam vessels running between New York and Albany, two between New York and Connecticut ports, four or five between New York and New Jersey ports, besides ferryboats on the Hudson and East Rivers. There were also steamers on the Delaware, between Philadelphia and Trenton, Newcastle, and Wilmington; also steamers from Baltimore to Norfolk, Virginia, which crossed the estuary of the Chesapeake. Steamers had been to New London and New Hartford. The *Powhatan* steamer of New York was three days exposed to a gale in the open sea, after which it arrived at Norfolk, Virginia, and thence steamed up the James River to Richmond. At that time, according to this witness, there were on the Mississippi two steamers, the *Etna* and *Vesuvius*, which were each of 450 tons, carried 280 tons of merchandise, 100 passengers, and 700 bales of cotton.

Towards the middle of the last century numbers of steamboats were placed on the coastal and river services from New York. The Fulton ferryboats *Union* and *William Cutting* were both built in 1827; and in the following year the *De Witt Clinton* was built in Albany for the passenger service between New York and Albany; she was 571 tons gross, more than any of her contemporaries. A notable vessel, then the fastest steamboat ever built, was the *Lexington*, which began to run in 1835 between Providence and New York. As the railway companies were formed about the same time, the competition between the steamboat companies and the railways was lively and fares were reduced with American thoroughness. The *Narragansett* arrived at Providence in October 1836. She was fitted with a 300-horse-power horizontal engine, which was too heavy for her, for on her trial trip she rolled over with the directors of the

company and their guests on board. Fortunately no lives were lost. In 1838, the *John W. Richmond* appeared as the rival of the *Lexington* and there were many exciting races between the two, but two years later the *Richmond* was sold for employment elsewhere. The *Lexington* was burnt in 1840, and the *Richmond* met with a similar fate three years later. The Fall River Line was established in 1847 and has maintained the service to the present day.

All these steamers were built of wood, and as they increased in size they developed a marked tendency to "sag," that is, drop in the middle, or to "hog," that is, drop at the ends. This tendency was overcome by an ingenious system of stump-masts and strutts, and iron ties, invented by Colonel Stevens. There are various methods of applying these stiffeners, and the peculiar framework of wooden arches and stump-masts which appears on so many American river steamers is due to the necessity of employing one or other of these systems for strengthening purposes. In some of the later vessels (as in the *De Witt Clinton*) these ties are put into the framework of the superstructure.

In construction, the development of American steamers on inland waters since Fulton's time has proceeded on entirely different lines from those which marked the progress of river navigation in Great Britain. American river steamers were designed not only to cope with the traffic in narrower and shallower places, but to carry whatever was necessary in deeper waters, and at the same time get through the more difficult places somehow. The great distances to be travelled on the American rivers rendered necessary the provision of vessels carrying large quantities of cargo and extensive accommodation for passengers, whilst the bars occurring at intervals in the beds of the rivers made it compulsory that the vessels should be of light draught. The construction of English river steamers, on the other hand, has been



The "De Witt Clinton." Built 1828.

p. 46

conditioned by the comparative narrowness of the English rivers and the lowness of the many bridges which span them.

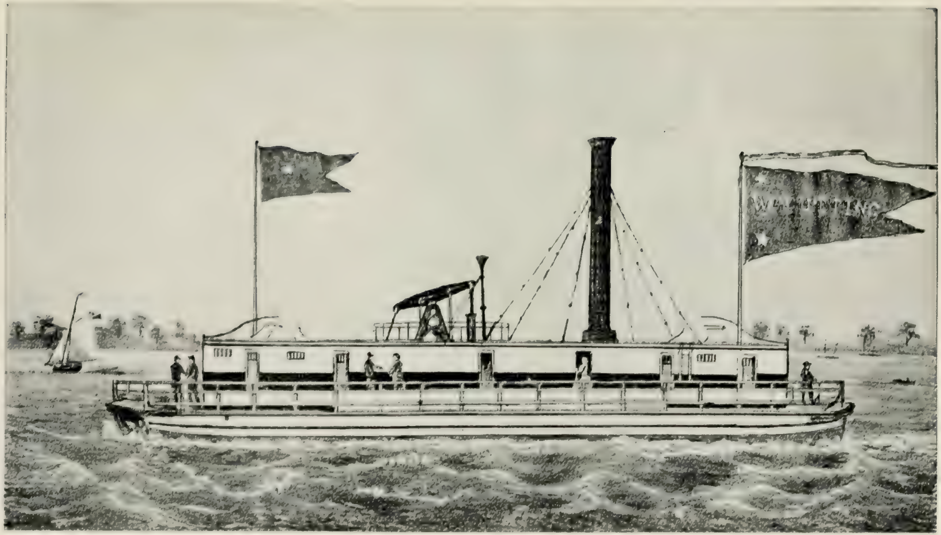
The Fall River Line boats were the pioneers of the modern type of Hudson River steamers, the first of them being the famous *Bay State*, plying between New York and Fall River. She was 315 feet long and 40 feet beam and of 1500 tons burden. Her engines were of 1500 horsepower. The *Bay State*, being intended for Long Island Sound work, was much more strongly built than those boats which were confined to the Hudson River Line. This vessel was both the largest and fastest craft of her day. She ran the distance from Fall River to New York in nine hours fifteen minutes, including a stop at Newport. In 1864 she was dismantled, and her hull was converted into a barge, her machinery being placed in a new steamer named *Old Colony*. Vessels followed each other in rapid succession, but although rival companies sprang up with considerable frequency, few of them lasted very long and their boats, if good enough, were sometimes acquired by the Fall River Company. One of the most dangerous competitors was the Merchants' Shipping Company, which controlled fifteen steamers, and for which William H. Webb, the famous American shipbuilder, constructed those two historic boats, the *Bristol* and the *Providence*. The line lost two or three of its steamers in rapid succession, and had to suspend payment. The *Bristol* and *Providence* had each two hundred and twenty-three state-rooms. They were lighted by gas throughout, and were afterwards steam-heated. Each boat carried a band of music, and for the first time on an American merchant vessel the officers and crew were in uniform. In 1883 the first iron steamboat in Long Island Sound, the *Pilgrim*, was built. She had a double hull divided into ninety-six water-tight compartments. The *Puritan* followed her. The *Plymouth* was launched in 1890, and was

burnt in dock ten years later, and in August of the following year the present *Plymouth* was launched. All these vessels were side-wheelers, the later ones being of steel, and having a speed of twenty miles an hour.

One of the finest vessels now afloat is the *Commonwealth.* She is 456 feet in length, 35 feet moulded breadth, 96 feet breadth over the guards, and has a depth of hull of 22 feet. She has sleeping accommodation for 2000 persons.

Like all steamers on the Fall River Line, the *Commonwealth* is built of steel. Seven doorless bulkheads extend to the main deck. The hull is double, and the space between the bottoms is divided into a great many water-tight compartments. She has also collision bulkheads on each side at the guards and a bulkhead athwart ship. Her engine is of the double inclined compound type, with two high-pressure cylinders 96 inches in diameter, all having a common stroke of piston of 9 feet 6 inches. The wheels are of the feathering type with curved steel buckets. Besides the usual auxiliary steam pumps, there is a large pump for use only on the fire-sprinkler system. Her speed is twenty-two miles an hour.

During the nineteenth century there was an equally striking development among the steamers of the various lines on the Hudson River. The *Empire of Troy*, to distinguish her from another steamer called the *Empire* built in the 'forties and belonging to a rival line, was then the largest river steamer in the world, being 307 feet over all and of 936 tons register. She was quickly superseded by the *Hendrick Hudson* of the Albany Line, which was the first Hudson River steamer to exceed a thousand tons. This in turn was eclipsed by the *Oregon.* The *St. John*, of 2645 tons, built in 1863, was the first to exceed 2000 tons, The *Adirondack*, of 3644 tons, was placed on the river in 1896, and in 1904 the *C. W. Morse*, of 4307 tons, appeared.



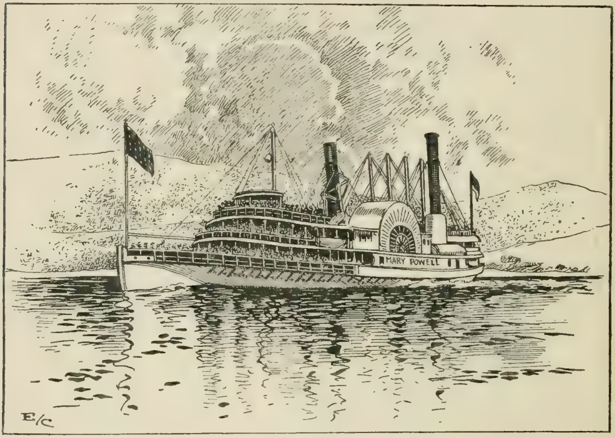
THE "WILLIAM CUTTING." BUILT 1827.

p. 18

The Hudson River boats, after the first or experimental types of vessel, have always been famous for their speed and beauty no less than their comfort. One of the most famous of them all was the *Alida*. Two others, which raced occasionally, were the *Oregon* and the *C. Vanderbilt*, one notable contest in which they engaged being in 1847, for a stake of 1000 dollars. On the way back the *Oregon* ran short of fuel, whereupon the owners threw into the furnaces the furniture and everything else that would burn which they could lay hands on. The time of the run was 3 hours 15 minutes, which gave an average speed of 20 miles an hour. After the heroic sacrifice made by the Oregonians, it is satisfactory to learn that the *Oregon* won by 400 yards. The *Alida* and the *Hendrick Hudson* raced from New York to Albany, the former doing the voyage in 7 hours 55 minutes, the latter boat being 15 minutes longer on the voyage. The scheduled time of the present Hudson River Day Line steamers over the same water is 9 hours 30 minutes, from which it would appear that the boats of sixty years ago were as capable of fast travelling as are their palatial successors of the present day. One of these, a second *Hendrick Hudson*, was launched on the Hudson in 1907, a hundred years from the day of the *Clermont's* first voyage up the river.

The decade from 1840 to 1850 was the golden age for steamboat proprietors on the Hudson River, as there was then no railroad competition, though there were several competitive steam-ship companies. In 1849 there were no less than twenty steamers on the route between New York and Albany, and the fares were cut as low as 12½ cents for the 145 miles. One of the steamers on the river in the 'forties was the *Norwich*. A few years later she was converted into a tug-boat, and up to the end of 1909 was still in active service. She has been repaired so often, however, that not much of her original hull is left, but her

first engine is still in use. A steamer which is still held in affectionate memory by all frequenters of the Hudson River, the celebrated *Mary Powell*, was launched in 1861, and was never eclipsed in speed by any vessel until the modern torpedo-boats were built. She frequently covered



THE "MARY POWELL"

27 miles an hour. This remarkable boat came from the New Jersey yards of Messrs M. A. Allison. Originally she was 260 feet in length, but in 1874 she was increased to 286 feet, and again in 1897 to 300 feet. Her paddle-wheels were 31 feet in diameter, with 26 floats to the wheel, each float being $10\frac{1}{2}$ feet long by 1 foot 9 inches wide and dipping $3\frac{1}{2}$ feet. One vessel, the *Glen Cove*, attained notoriety if not fame by being the first to carry that novel musical instrument known as the calliope. Fortunately for New Yorkers, the innovation was not

THE "HENDRICK HUDSON" (HUDSON RIVER DAY LINE), 1906.

p. 50

popular. The machine consisted of a large steam chest, on the top of which were arranged a number of valves according to the number of whistles to be blown. As a powerful calliope could be heard for a distance of some miles, and as the instrument frequently consisted of from eight to twelve whistles, and the selection performed upon it was of the " Shall we gather at the river " variety, it cannot be said that the English have been the only people to take their pleasures sadly. Three boats plying in New York Bay carried these excruciating instruments. The *Glen Cove* was sold with her calliope to ply on the James River in Virginia, and was sunk by the Confederates during the Civil War. The most aggressive calliope was carried on the *Armenia.* It had thirty-four powerful whistles.

In 1860, the *Daniel Drew*, a long and very narrow boat, reduced the time of the voyage to Albany to seven hours twenty minutes. It is impossible for the heavy steamers of the present day to travel on the up-river stages as fast as the lightly built boats of that time, but in the deeper waters of the lower river they are faster than the lighter vessels. A steamer of the latest type is the *Robert Fulton*, built for the Day Line by the New York Shipbuilding Company of Camden, N.J., and the W. and A. Fletcher Company of Hoboken. Her trials took place exactly 116 days after her keel was laid, and she began to run in 1909.

The development of the steam-ships on the lakes was no less remarkable than on the sea-coasts. At the outset the boats were of wood, which was gradually superseded first by iron and then by steel, and with the introduction of the latter has come also their greatest development in carrying capacity. The first steamer placed in service on the Great Lakes, above Niagara Falls, was launched in 1818, and bore the picturesque Indian name *Walk in the Water*, after a noted Wyandotte chief. She was of

338 tons gross and built at a spot which is now a part of the City of Buffalo. The machinery was furnished by Robert McQueen of New York, one of her owners.

By 1844 there were three large steamers of over 1000 tons each on the lakes, built wholly for the American passenger service from Buffalo. The first screw-propelled boat on the lakes was the *Vandalia*, built at Oswego in 1841. She was one of the earliest vessels to have her machinery placed right aft. By 1849 there were enrolled at Buffalo, which was the chief lake port, 29 side-wheelers, 18 of which were of from 500 to 1500 tons, and 10 screw-propelled boats of under 500 tons, but by 1862 the number of steamers had increased to 147 side-wheelers and 203 screw-propelled boats. The construction of the Welland Canal and the Sault Ste. Marie Canal with larger locks than hitherto had a most stimulating effect on lake shipping. American ingenuity devised freight-carrying steamers peculiarly adapted for work on the lakes. The largest boat on the Great Lakes is the *William M. Mills*, a "bulk-freighter." She is virtually an immense box girder 607 feet in length, 585 feet length of keel, 60 feet beam, and 32 feet in depth, with triple-expansion engines. She is built on the hopper and girder system, and has a cargo hold 447 feet long without obstruction other than three screen bulkheads fitted for convenience in carrying grain; her cargo capacity is 514,505 bushels of wheat. She and her two sister ships can each carry 12,380 tons of ore. Her water-ballast tanks will take 7000 tons, and her pumps are so powerful that the whole of this quantity can be discharged overboard in three hours. The officers and crew are accommodated in a deck-house situated on the forecastle. Above this deck-house are the navigating bridge and steering-house. The engines are placed at the extreme end of the vessel, so that the whole space between the engine bulkhead and the forecastle is devoted to the cargo. The

THE "ROBERT FULTON" (HUDSON RIVER DAY LINE), 1909.

p. 52

scantlings of the hull throughout are the heaviest on fresh water.

On the Mississippi River and its tributaries a type of large shallow steamers, propelled by immense side or stern paddle-wheels, was developed. These vessels were noted for their high superstructures and towering funnels. Racing was frequent among them.

In April 1838 the Mississippi River steamer *Moselle*, crowded from stem to stern with passengers for St. Louis, blew up. She had gone a little way up the river from Cincinnati for the purpose of exhibiting herself and of coming back past the city "a-flying." As she stopped to turn, the boilers exploded, blowing the ship to fragments. The captain, who was in the pilot-house, was blown about eighty yards away; a boy on board was found dead on the roof of a house on shore. It was never known exactly how many perished, but the number is estimated at anything from one hundred to two hundred. One of the boilers was thrown ashore by the explosion, and in falling made a large hole in the pavement.*

Another accident of that year befell the steamer *Oroonoko* on the Mississippi. Her boilers blew up and, the wreck taking fire, about one hundred lives were lost, most of the victims being burnt to death. The engineer, before he died, said the boilers were full of water, and that his department was not in fault, but that the boilers were old and worn out and not fit for such a boat.†

About the same time two other steamers, the *Pioneer* and *Ontario*, were racing on the river near Cincinnati and collided. The *Ontario* ran purposely into the *Pioneer*, which returned the compliment by deliberately ramming the *Ontario*, killing one passenger, dangerously wounding two others, and smashing the *Ontario's* guards. The *Pioneer* won that race, but intentional collisions were too much

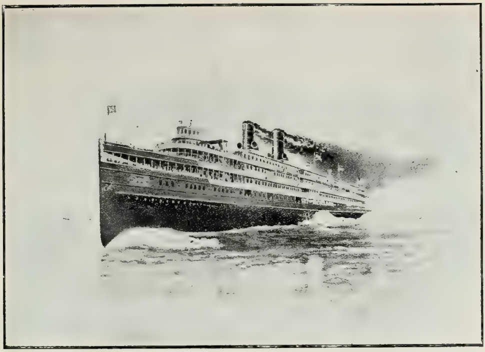
* Cincinnati *Evening Post,* April 25, 1838.

† Vicksburg *Register.*

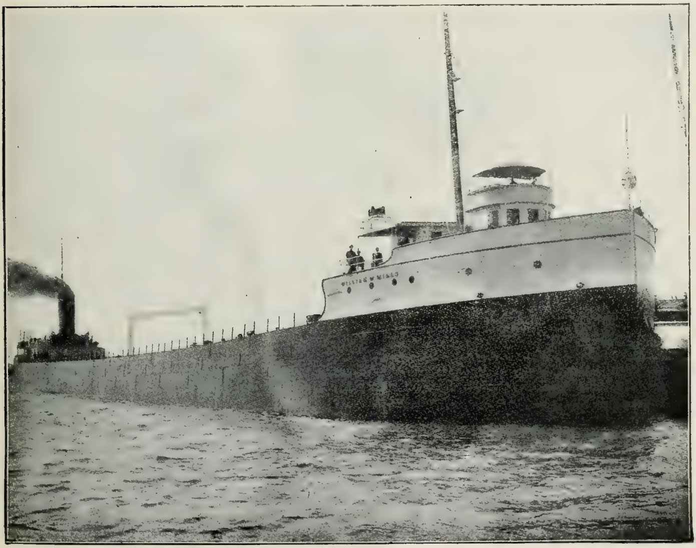
even for the sensation-loving public which patronised the racing Mississippi steamers and used to bet heavily on the result, and dangerous racing of this character was for a time tabooed.

One of the most famous races on record was that between the *Eclipse* and the *Natchez*, two magnificent vessels which were very evenly matched. It is recorded that the immense funnels of these two boats, as they tore along almost on a level with only a few feet between them, were red-hot, and that the blaze from their pine-fed furnaces made the dwellers on either side of the bank think that the vessels were on fire.

The finest passenger steamer which has ever been placed on the Lakes is, without exception, the *City of Cleveland.* The hull, built of mild steel, is divided into ten compartments by water-tight cross bulkheads extending from the keel to the main deck. The double bottom, which reaches nearly the entire length of the ship, is also divided into ten compartments, which can be used for water-ballast, and she has a steadying tank holding 100 tons of water and situated amidships to check the rolling in a heavy sea. The *City of Cleveland* is 400 feet over all, 390 feet keel, 54 feet across the hull, and has a depth of 22 feet. Like nearly all American paddle-steamers she is decked to the full width of the guards. She has seven decks, the main deck, which is of steel, being sheathed with wood to deaden the noise of the handling of cargo. Her electric plant provides 1500 lights, as well as a search-light of 50,000 candle-power. Her engine was constructed by the American Shipbuilding Company and consists of an inclined three-cylinder compound engine, the high pressure being arranged between the two low-pressure cylinders. The high-pressure cylinder is 54 inches in diameter and the low-pressure cylinders are each 82 inches and the stroke of piston is 8 feet. The paddle-wheels are 29 feet in diameter and are fitted with feathering blades, each of which is



The "City of Cleveland."



The "William M. Mills."

p. 54

14 feet long and 4 feet wide. This steamer makes two trips a day between Detroit and Cleveland, and is credited with having attained to a speed of twenty-four miles an hour.

The Canadian-built lake steamers are similar to those from United States yards, and a typical specimen of colonial construction is the *Midland Prince*, launched in 1907 by the Collingwood Shipbuilding Company of Collingwood, Ontario, which, like the *Collingwood*, is an immense freighter.

One or two "whalebacks," a type designed for the Lakes by Captain McDougall, have been seen on the Atlantic occasionally, but they were not a great success. A vessel of this type visited Liverpool some years ago, the *Charles Wetmore*, and having her engines placed aft, and being built with a perfectly flush whaleback, without hatchways, and with a "scow and pig-snout" bow, was a decided curiosity. The ingenuity of her design and the excellent workmanship displayed in her construction impressed naval architects favourably, but there was nothing to show that she was superior as a cargo vessel to the single-deck steamers on this side of the Atlantic. The whaleback steamer is less in favour than it was, even in America, but a good many of them are still to be seen on the Lakes and the Pacific coast.

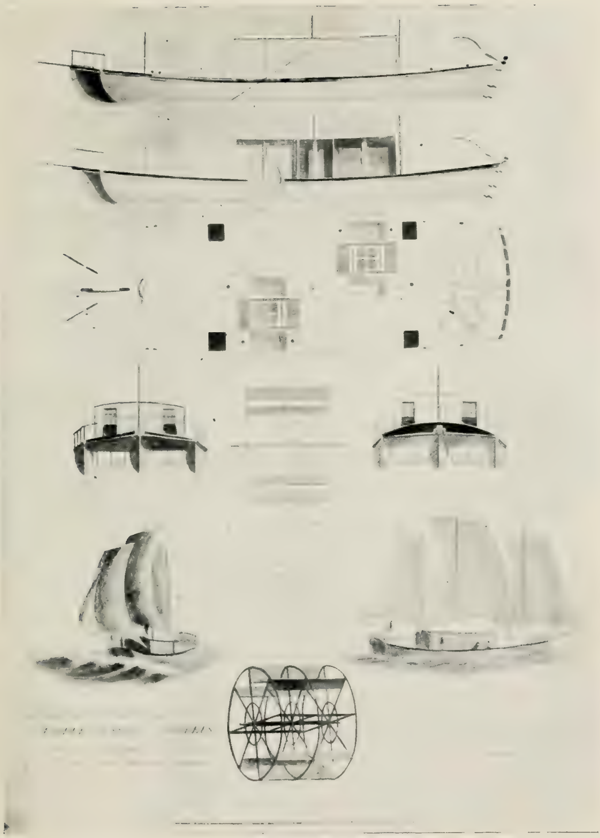
CHAPTER III

THE PROGRESS OF STEAM-SHIP BUILDING IN GREAT BRITAIN

THE first steam-ship built in the United Kingdom (and so far as is known unnamed) was constructed on the River Carron in 1789 by William Symington, and the engines for it were made at the Carron Works at a cost of £363 10*s*. 10*d*. The following affidavits relating to this vessel are of interest, as they go far to prove that William Symington was the inventor of the marine steam-engine, the patent of which was taken out in 1786 :

"I, William Symington, civil engineer, now residing at Falkirk, in the County of Stirling, in that part of the United Kingdom called Scotland, produce herewith, and refers* to a memorial containing a narrative of his connection with the invention of steamboat navigation, each page of which memorial is subscribed by the deponent as his relative hereto, and he maketh oath and sayeth that the said memorial contains a true narrative of facts, as connected with the said invention ; and he further sweareth that he did not receive any aid or assistance of any kind to enable him to invent and apply a steam-engine to the propelling of boats.

* *Sic* in original.



Patrick Miller's Triple Boat the "Edinburgh." p. 56

"Sworn at Woodburn, in the County of Stirling, upon the first day of December, in the year one thousand eight hundred and twenty-four, before me, one of His Majesty's Justices of the Peace for the County of Stirling.

"(Signed) William Symington.
"(Signed) John Callander, J.P."

"Joseph Stainton Esq., of Biggarshiels, manager for Carron Company at Carron, in the County of Stirling, in that part of the United Kingdom called Scotland, maketh oath, and sayeth: That he knows William Symington, engineer at Falkirk. That he has access to know that the said William Symington made certain experiments in the year one thousand seven hundred and eighty-nine, by applying a steam-engine to propel a boat along the Forth and Clyde Canal. That the machinery for said experiment was made at Carron, under the direction of the said William Symington, and the expense thereof, amounting to three hundred and sixty-three pounds, ten shillings and ten-pence, was paid to Carron Company by the now deceased Patrick Miller, Esq., of Dalswinton. That the deponent has seen the boat in which the said experiments were made, and has frequently heard of the experiments mentioned. That in the year one thousand eight hundred and one, or about that time, the said William Symington was employed by the now deceased Thomas Lord Dundas to erect a boat and construct a steam-engine to propel it along the said canal. That the deponent saw the said boat when completed, and had access to know that it was employed in the way of experiments to drag vessels along the canal. That it consists with the deponent's knowledge, Robert Weir was employed by the said William Symington about the said boat. That he knew the said Robert Weir, who now resides at Kincardine, to be a man of respectable character and of veracity. That the said William Symington

afterwards constructed a larger boat, and the deponent had access to see both the boats, and to know that they were propelled by steam."

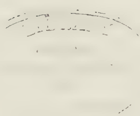
"Sworn at Carron, in the County of Stirling, upon the thirtieth day of November, one thousand eight hundred and twenty-four, before me, one of His Majesty's Justices of the Peace for the County of Stirling.

"(Signed) JOHN CALLANDER, J.P.
"(Signed) J. STAINTON." *

Scotland owes her pre-eminence in shipbuilding and marine engineering to Patrick Miller, an Edinburgh banker who, having retired with a large fortune to Dalswinton, among other things set himself to ascertain whether some better means of propelling vessels than sails or oars could not be obtained. He had exhibited at Leith a triple vessel "having rotatory paddles in the two interspaces driven by a crank," which was turned by four men. This he matched against a fast-sailing Customs wherry between Incholm and Leith Harbour over a distance of six or seven miles, and was very well satisfied with the victory he secured. But his sons' tutor, James Taylor of Cumnock, having taken his turn at the crank, was so convinced by the violence of the exertion that some more reliable power was needed, that he urged on Mr. Miller the propriety of employing a steam-engine. Mr. Miller had placed a new double boat on his lake at Dalswinton, and Taylor, with his permission, arranged with his friend William Symington to fit it with a steam-engine. Symington, who was then engaged as a mining engineer, at Wanlockhead, had constructed a model of a steam carriage in which he had converted the reciprocating motion of the pistons into a rotatory motion. Miller and Taylor were shown this model in December 1787. The engine had only four-inch brass cylinders, made, curiously enough, by George Watt

* "A Century and a Half of Commercial Enterprise," by the Carron Company.

MODEL OF MILLER'S DOUBLE BOAT. *p. 58*

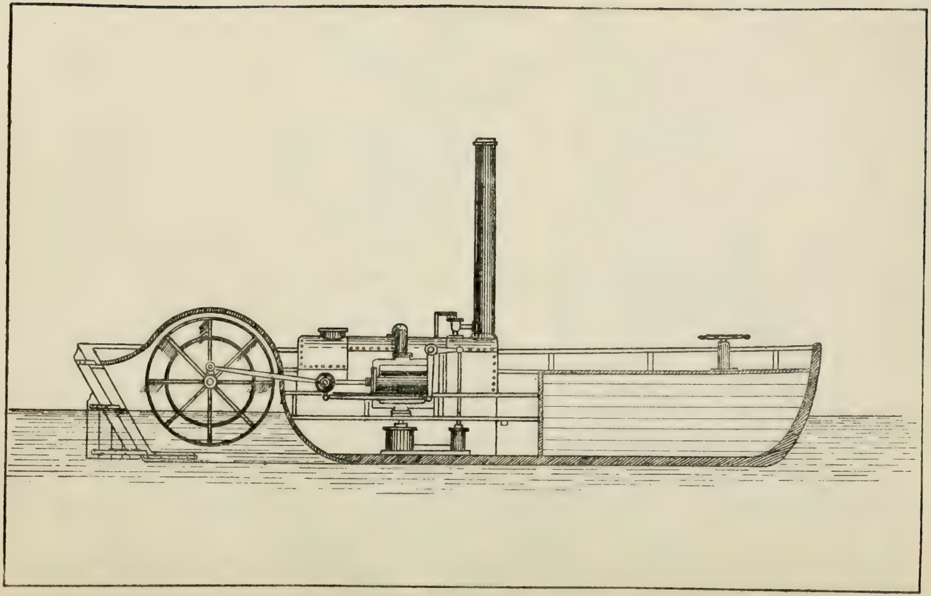


of Edinburgh. The trial trip of Miller's boat took place on October 14, 1788, in the presence of several hundreds of people, and was so successful that Miller resolved to repeat the experiment on a larger scale. In the next year a twin vessel, 60 feet long and fitted with an engine with 18-inch cylinders, attained a speed of seven miles an hour on the Forth and Clyde Canal. For some reason Miller became dissatisfied with Symington, and abandoned his project of making a sea trip with a third vessel from Leith to London. The cost of fitting up a second vessel, for one thing, was greater than he had anticipated, and he was further discouraged by a miscalculation through which the machinery was made too heavy for the hull. Symington's original engine of 1788 is now at South Kensington, and a photograph of it is here reproduced.

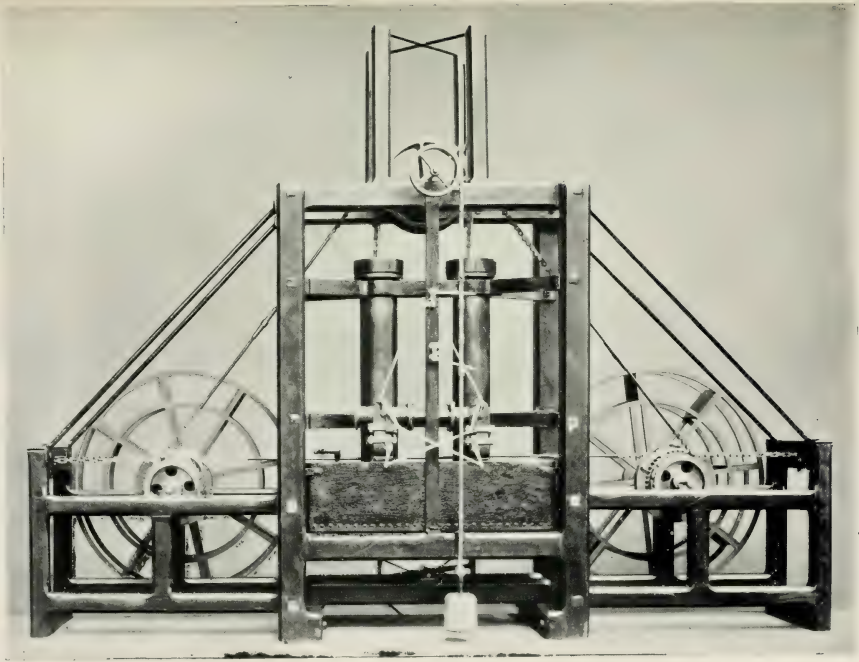
Symington was the only one of the three who persevered.* He brought his design for a steam vessel under the notice of Lord Dundas, who was largely interested in the Forth and Clyde Canal, and suggested to him the advisability of towing barges by steam-power. The *Charlotte Dundas* was accordingly built in 1801 under the patronage of Lord Dundas, and made her appearance on the canal in 1802. The propelling machinery of the vessel was a long way in advance of the time, inasmuch as it consisted of a stern wheel driven by the first horizontal direct-acting engine that was ever constructed.† She was 56 feet in length by 18 feet beam and 8 feet depth, and towed two barges of 70 tons a distance of nineteen and a half miles in six hours against strong winds. But complaints were made that the swell she created damaged the canal banks, and her proprietors were forced to abandon the enterprise. Thus the *Charlotte Dundas*, though an unquestioned engineering success, was a commercial failure, and on being withdrawn

* *Chambers' Journal*, 1857.

† Sir G. Holmes' "Ancient and Modern Ships."

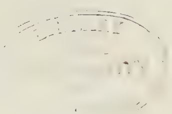


The "Charlotte Dundas" (Longitudinal Section)



Symington's Original Engine of 1788.

p. 60



from service was laid up in Lock No. 16 and allowed to rot, a monument to the genius of her constructor and the prejudice of those who were too ignorant to recognise the obvious. A photograph of the model at South Kensington Science Museum, and a section showing her machinery, are given here.

Symington also brought his steamboat to the notice of the Duke of Bridgewater, who became his patron and comtemplated trying steam-towage upon the Bridgewater Canal; but on the Duke's death his executors repudiated the verbal contract and dashed Symington's hope to the ground. He was reduced to abject poverty, and died in the East End some years later.*

The next experiment of importance in steam navigation was made by Henry Bell of Helensburgh. He was a house carpenter at Glasgow for many years, and then, having opened a boarding-house at Helensburgh, he conceived the idea of inducing more visitors to go thither by providing for their convenience boats moved by paddles worked by manual labour. This failing, he determined upon a steamboat.

He was probably influenced in his decision by the correspondence he had with Fulton. The exact nature of the relations between Fulton and Bell has never been satisfactorily determined. The *Caledonian Mercury* in 1816 published a letter from Bell stating that Fulton wrote to him about Miller's boats, and asked for a drawing and description of the machinery. Bell saw Miller and sent Fulton the required information. The date of this transaction is not given, though Fulton is said to have written afterwards to Bell that he had constructed a steamer from the drawings Bell sent.

Bell's story was that these letters were left in Miller's hands. Bell further states that the consideration of the absurdity of writing his opinion to other countries, and

* *Notes and Queries.*

not putting it into practice himself, roused him to design a steamboat for which he made various models. The result was the *Comet*, built for him by John Wood and Co. She was 40 feet on the keel, $10\frac{1}{2}$ feet beam, and about 25 tons burden. The vessel was inferior to Symington's. The furnace was enclosed with brickwork and the fire was not wholly surrounded by water. The boiler was placed at one side of the vessel, and the funnel, bent so as to rise from the centre, also had to do duty as a mast.

Bell had previously witnessed the experiments made in 1789 at Carron with Miller's second boat, and when Symington's experiments came to an end in 1803 he continued to investigate on his own account.

He advertised that his vessel was for passengers only, and that he had "at much expense, fitted up a handsome vessel to ply upon the River Clyde, between Glasgow and Greenock, to sail by the power of wind, air, and steam." The vessel was to go down to Helensburgh one day and return the next, thus making three trips each way in the week. Many of the sailing-boat owners regarded the *Comet* with undisguised hatred, and its invention as a device of the evil one. Thus, one Dougal Jamson, a Clyde skipper, whenever the steamboat passed his slow-going sloop,* invaribly piped all hands—a man and a boy —and bade them "Kneel down and thank God that ye sail wi' the A'michty's ain win', an' no' wi' the deevil's sunfire an' brimstane, like that spluttery thing there."

The *Comet's* engine, which was built by John Robertson, was of four nominal horse-power with a single upright cylinder of $12\frac{1}{2}$ inches diameter and 16 inches stroke, and drove a pair of half side-levers by means of two rods. A connecting-rod from the levers worked the crank shaft, which carried a heavy fly-wheel. The slide valve was driven by an eccentric on the main shaft through a rocking shaft, while the condenser was placed

* *The Steamship,* January 1883.

Model of the "Charlotte Dundas."

p. 62

between the side-levers, which drove the vertical air-pump. Originally the engine was fitted with a smaller cylinder, but after being used for some months this was replaced by the one described. Steam was supplied by an internal flue boiler, built by David Napier. The vessel was originally propelled by two paddle-wheels on each side, driven by spur gear, with the paddles on detached arms, but this arrangement giving trouble, complete wheels were substituted, and subsequently, after the vessel had been lengthened about 20 feet, the number of wheels was reduced to two.*

They had considerable difficulty with the boiler. Its builder, David Napier, writes that they first tried to make the internal flues of cast iron, but finding that would not do they tried malleable iron, "and ultimately succeeded by various devices in getting the boiler fitted." The *Comet's* first master was William Mackenzie, originally a schoolmaster at Helensburgh, and the engineer was Robert Robertson. The crew numbered eight, not forgetting a piper. According to an advertisement, "the elegance, safety, comfort, and speed of this vessel require only to be seen to meet the approbation of the public."† But her speed was unsatisfactory and Bell arranged with Robertson to make alterations in the engine and paddle-wheels. She then made six miles an hour, but even this was not sufficient to attract passengers. The boat was not a financial success, and it is believed that neither the builders' nor Robertson's accounts were ever settled. The career of the *Comet*, indeed, was not a long one. On December 13, 1820, she was wrecked outside Crinan. She parted amidships, and while the stern drifted away the remainder of the vessel, with Bell, his crew, passengers, and machinery, stuck fast. All scrambled ashore, and the

* "The Clyde Passenger Steamers," by Captain Williamson, and Catalogue of the Victoria and Albert Museum, London.

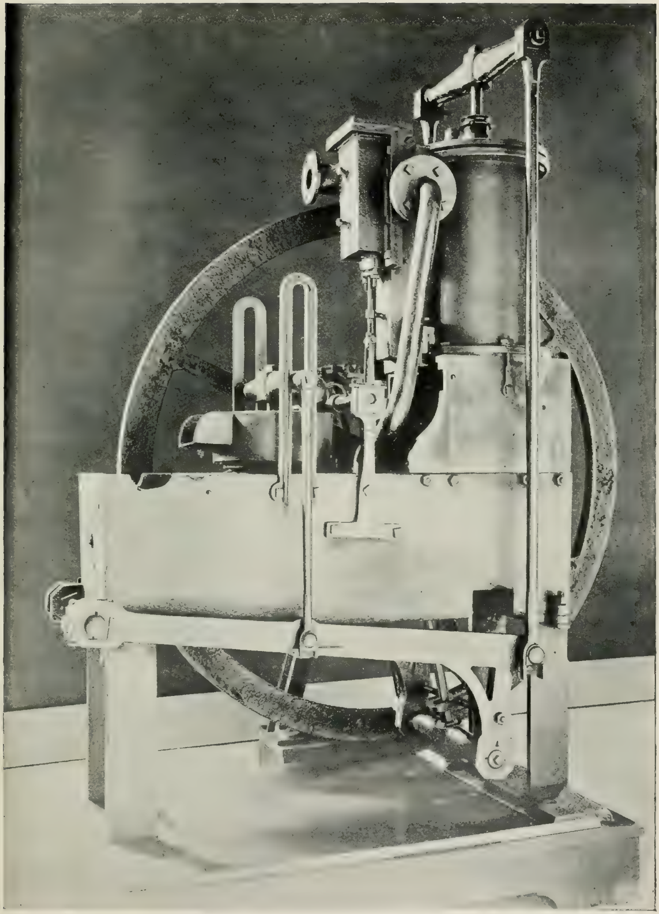
† The *Glasgow Chronicle*, August 14, 1812.

machinery was afterwards recovered. Her original engine was put to some strange uses. A Glasgow coachbuilder took it as payment for a vehicle he had previously supplied to Bell, and used it to drive the machinery in his coach-works. It then went to Greenock and was installed in a brewery. Another purchaser brought it back to Glasgow, and it ultimately came into the possession of Messrs. R. Napier and Sons of Glasgow, and Messrs. R. and J. Napier in 1862 presented it to the South Kensington Museum.

But the *Comet* was not the only boat with which Robertson was concerned. Wood built the *Clyde* for him in 1813, and she began her work in June of that year. She was 72 feet long with a beam of 14 feet and depth of 7 feet 6 inches, and regularly went from Glasgow to Gourock and back in about $3\frac{1}{2}$ hours each way, including a few stoppages, on a coal consumption of 24 cwt. The *Tay* was built for him at Dundee in 1814, but he had the engine built at Glasgow. She plied for some time between Perth and Dundee, and in 1818 was back at Glasgow, being then known as the *Oscar*. In 1814 Robertson had two other boats built at Dundee, for which he provided the engines. These were the *Caledonia* and the *Humber*, and are thought to have been the first steamers sent from Scotland to England.

Rivals quickly appeared on the scene, for the *Comet* had shown that what had hitherto been looked upon as an impossible undertaking could now be regarded as a commercial speculation. In 1813 the *Elizabeth* was built and was followed shortly afterwards by the *Clyde*. The *Elizabeth* was sent to Liverpool and was the first British steamer to make a sea voyage. The vessel was in charge of Colin Watson, his cousin, neither of them nineteen years of age, and a boy.* The engine of the *Elizabeth* was only

* Letter from Mr. K. Y. Watson in the second edition of Mr. John Kennedy's "History of Steam Navigation."



THE ORIGINAL ENGINES OF THE "COMET." *p.* 64

8 horse-power. The three adventurers brought the vessel in safety from Glasgow to Liverpool through a violent gale—a very remarkable performance. This voyage was made in 1815.

Watson left Glasgow for Grangemouth on May 8, and on the following day started from Grangemouth with the *Elizabeth*, bringing her along the canal. Obstacles of one sort or another caused detention in the canal, specially at Lock No. 27, and Bowling was not reached until May 12. The voyagers arrived at Port Glasgow on the 13th, where another stay was made while the damages sustained in navigating the canal were repaired, and preparations were made for the sea voyage.

The Clyde was left on June 2, but the little vessel had to be brought up in Lamlash, Isle of Arran, there being a "dreadful storm at night," as the captain narrates. They sailed from Lamlash about one o'clock in the afternoon of the 4th, "and after undergoing great peril, reached Port Patrick the same night twelve o'clock." A lengthy stay was made there, due partly to an accident, the nature of which is not stated, "but principally the want of money," till Saturday 24th, when they left Port Patrick. The *Elizabeth's* adventures were by no means over, for she was obliged to bring up in Ramsay Bay, Isle of Man, an accident throwing off one of her paddles. The financial difficulty having been further overcome to the extent of six guineas, the *Elizabeth* left the Isle of Man with a fine breeze, "day lovely, but, after working all day and night, we found on the morning of Wednesday 28th, we had been deceived by our compass and were off the coast of Wales.

"We again unshipped our paddles, and drifted nearly to Dublin ere we could again get them to work, but luckily did effect that and anchored off George's Dock Pier, Liverpool." *

* The full log appears in Mr. Colin Watson's "Doubly in Crown Service"; the original log is stated to be perserved in Brown's Museum.

Another famous vessel of this period was built in 1814 at Fairlie by William Fyfe. This was the *Industry*, known in later years as the *Coffee Mill* because of the grinding noise made by the cog-wheels in her machinery.* She is also remarkable as being the only trading steamer ever built at the Fairlie yard, for William Fyfe steadfastly refused to construct anything but yachts and smart fishing smacks.†

The year 1814 saw the building of the *Princess Charlotte* and *Prince of Orange*, the first British steamers with engines by Boulton and Watt. In the same year at Dumbarton, Archibald MacLachlan built the *Marjory*, the first steam vessel to enter the Thames. She was sent through the Forth and Clyde Canal and down the east coast, and as her beam was wider than the canal locks her wings had to be removed.

Steamship building now proceeded with great energy. In 1815 boats were built in Ireland at Cork, and the first voyage of a steamer from Glasgow to London was made by the *Thames*, while in England the London river steamboat service was opened.

The *Thames*, previously the *Argyle*, is described by the *Times*, July 8, 1815, as a steam yacht, and as a "rapid, capacious, and splendid vessel," which "lately accomplished a voyage of 1500 miles, has twice crossed St. George's Channel, and came round the Land's End with a rapidity unknown before in naval history. . . . She has the peculiar advantage of proceeding either by sails or steam, separated or united, by which means the public have the pleasing certainty of never being detained on the water after dark, much less one or two nights, which has frequently occurred with the old packets."

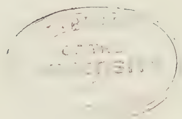
The *Thames* always did her journey, a trip to Margate,

* Mr. John Hastie's Address to the Institute of Engineers and Shipbuilders in Scotland, December 2, 1880.

† "The Clyde Passenger Steamers."

The "Comet," 1812.

p. 66



in one day. "Her cabins," says the *Times* eulogist, "are spacious and are fitted up with all that elegance could suggest or all that personal comfort requires, presenting a choice library, backgammon boards, draught tables, and other means of amusement. For the express purpose of combining delicacy with comfort a female servant tends upon the ladies." The *Thames* was of 70 tons register, 79 feet on the keel, 16 feet beam, and carried engines of 14 horse-power. Her funnel did duty as a mast, and carried a large square sail. "A gallery upon which the cabin windows opened projected so as to form a continuous deck, interrupted only by the paddle-boxes, an arrangement which had the further effect of making the vessel appear larger than she really was."* She also displayed on her sides eighteen large painted ports, besides two on her stern, which gave her such a formidable appearance that several naval officers stated in evidence before a Parliamentary Committee that they would have attempted to reconnoitre her before bringing her to. For in those days merchant vessels carried cannons and did not hesitate to show their noses through the ports if need were.

Her voyage to London was made under the command of a former naval officer named Dodd. She sailed from Glasgow about the middle of May, carrying, besides Dodd, a mate, engineer, stoker, four seamen, and a boy. The first night out they met a heavy gale, and instead of being off the Irish coast as Dodd intended, they found themselves in the morning perilously near Port Patrick, its rock-bound coast being less than half a league on their lee. Dodd saw that his only hope of safety was to run the engine for all it was worth, and the little steamer managed to fight her way against the wind and a tempestuous sea, gaining at the rate of about three miles an hour. Two passengers, a Mr. and Mrs. Weld, joined the ship at

* Kennedy's "History of Steam Navigation."

Dublin.* Weld's journal records that he went to see the vessel "and found her on the point of starting with a number of curious visitors upon an experimental trip in the Bay." He was so pleased that he asked Captain Dodd, who at once consented, to take him as a passenger to London, and Mrs. Weld "resolved on sharing the dangers of the voyage."

When the adventurous journey was resumed several persons went with them as far as Dunleary, now Kingstown, where they landed after being violently sea-sick owing to the rough water. Some naval officers on board prophesied that the vessel could not live long in heavy seas. Kingstown was left, and the steamer soon found herself in as rough a sea as ever. The next morning they arrived off Wexford. The smoke led the people to suppose the vessel was on fire, and all the pilots in the place put off to her help, but their dreams of salvage were disappointed. The weather becoming worse, Dodd sought safety in Wexford Bay. They sailed again for St. David's Head. Both paddle-wheels met with an accident and had to have a blade cut away, the vessel's progress, however, suffering but slightly in consequence. Milford Haven was safely reached, but when nearing the port they met the Government mail packet from Milford to Waterford under full sail. They had passed the packet about a quarter of a mile when Dodd thought he would send some letters by her to Ireland; accordingly the *Thames* was put about, overhauled the packet, and sailed round her. The letters having been put aboard, Dodd took his boat again round the packet, although the latter was under way, and then continued his journey. At Milford the engine and boiler were cleaned. But after leaving Milford the pilot declined to attempt to round the Land's End that night. Dodd put into St. Ives, where the *Thames* was again mistaken for a ship on fire. There being no shelter at St. Ives he

* *Chambers' Journal*, April 25, 1857.

p. 68

The "Industry," 1814.

went on to Hayle. Off Cornwall Head a tremendous swell from the Atlantic met the steamer, and the waves were of such a height as to render her position most alarming. Dodd battled on, and after a night's struggle rounded the Land's End. At Plymouth and Portsmouth officials and thousands of sightseers went to see her, and at Portsmouth the Port Admiral was asked to grant the voyagers a guard that order might be preserved.

The *Thames* steamed up the harbour with wind and tide at nearly fourteen miles an hour. A court-martial which was being held at the time on one of the warships hurriedly adjourned to witness the wonderful sight. Margate and London were reached in due course, the ninety miles' run from Margate to Limehouse being done in ten hours.

Sir Richard Phillips, in his "Million of Facts," published in 1839, writes: "In her first voyage to Margate none would trust themselves, and the editor and three of his family with five or six more were the first hardy adventurers. To allay alarm he published a letter in the newspapers, and the end of that summer he saw the same packet depart with three hundred and fifty passengers!" They must have been packed as tightly as herrings in a barrel.

Another steamer on the Thames in 1815 was the *Defiance.* She was possibly the first steamer to be built on the banks of the Thames, but as there is no discoverable record of the fact, it is equally possible she was built as a sailer, and was fitted with engines. The *Majestic* appeared in 1816, and is thought to have been the first steamer employed in towing ships. On August 28, 1816, she towed the *Hope*, an Indiaman, from Deptford to Woolwich at a rate of three miles an hour against the wind.*

It is recorded that prior to the appearance on the Thames of the *Marjory*, *Defiance*, and *Thames*, a man

* Kennedy's "History of Steam Navigation."

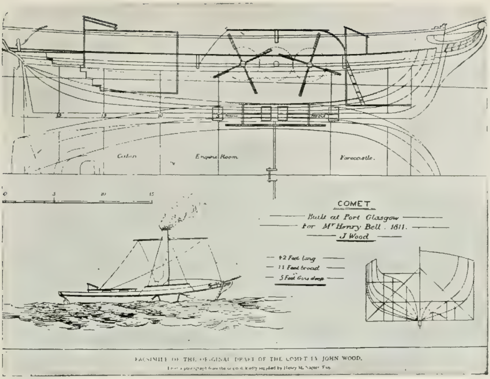
named Dawson in 1813 had a steamer on the river plying between Gravesend and London. This Dawson is stated to have made steamship experiments in Ireland, and according to his own account he built a steamboat of 50 tons burden, worked by a high-pressure steam-engine as early as 1811, which, by one of those singular coincidences frequently met with in the history of inventions, he named the *Comet.**

The first steam vessel known with certainty to have been built on the Thames was the *Regent*, designed by Isambard Brunel, and built in 1816 by Maudslay, the founder of one of the most famous shipbuilding firms London river has known. She was of 112 tons, with engines of 24 horse-power, and her machinery and paddles together were so light that they only weighed five tons. She was placed on the London and Margate passenger service, and in July 1817 was burnt off Whitstable. Fortunately no lives were lost.

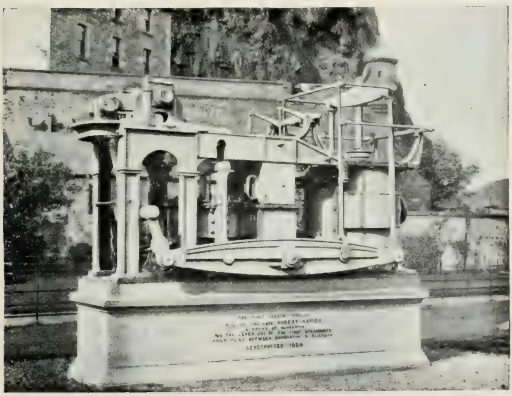
An apparently insignificant incident which occurred in 1818 resulted in one of the most important discoveries in the history of the marine engine. James Watt the younger happened to be on the steamer *Dumbarton Castle*, built a year earlier, when the engineer told him that the vessel had grounded the previous evening, and that the rising tide, turning the paddles the wrong way, had caused the engines to reverse. Watt explained to the engineer the importance of this, and at last took off his coat and showed what could be done with the engines. Before that date the reversing of machinery on steamers was either unknown or not generally practised. Watt's discovery enabled the steamer to take its position at Rothesay Quay with precision and promptitude, the custom previously having been to stop the engine some distance from the point of mooring and allow the vessel to drift alongside.†

* Stuart's "History" and Knight's "Cyclopædia."

† "The Clyde Passenger Steamers," by Captain J. Williamson.



PLAN AND LINES OF THE "COMET." *p.* 70



THE ENGINE OF THE "LEVEN." *p.* 70

PROGRESS IN GREAT BRITAIN

After the experimental voyages described above it was not long before owners of steam vessels and enterprising shippers generally recognised the benefits to be derived from the establishment of regular coastal steamship services. The year 1816 saw steam communication established between Great Britain and Ireland with the *Hibernia* of 112 tons register, which enjoyed the distinction of being the first boat employed in cross-channel service in the British Islands. She was built for the Holyhead and Howth service, was lugger-rigged, nearly 80 feet in length, and about 9 feet draught, and her passages averaged about seven hours.

David Napier now introduced a great change in the shape of the fore part of steamers' hulls, which added to the superiority of their speed over sailing ships. Hitherto steamers had been built with the bluff bows which characterised the sailers. Napier observed that the obstruction caused to a ship's progress by bows of this shape was very great, especially in dirty weather. He was crossing from Glasgow to Belfast on one of the sailing packets which then did the journey in anything up to a week, and perched himself on the bows, where he remained, heedless of the waves and spray which continually dashed over him. He was engaged in watching the bows and the waves, and thinking. Occasionally he turned to the captain and asked if the sea was rough. The captain said it could not yet be called very rough. The weather grew worse, and at last a tremendous wave, breaking over the vessel, swept her from stem to stern. Napier went back to the captain and asked, "Do you call it rough now?" The captain replied that he could not remember a worse night in his experience. To his astonishment Napier was delighted with this answer, and went down to his cabin remarking, "I think I can manage if that is all.*

* An account of this voyage by Napier is given in the American Admiral Preble's "History of Steam Navigation."

Subsequently he made a series of tank experiments with models, and these resulted in the adoption of the fine wedge-shaped bows which distinguished the steamships he afterwards built. This was the origin of the first great departure from sailing-ship models in steamboat construction.

In 1820 regular communication between Dover and Calais was established by the *Rob Roy*, a Scotch-built boat. In the previous year the *Talbot* had been built by Wood for the Holyhead and Dublin service. She was 92 feet long by 18 feet beam with a tonnage of 150. For this boat D. Napier provided the engines, while the first steamer engined by Robert Napier was the *Leven*, built in 1823. The *Leven's* engine, of the side-lever type, is still preserved on Dumbarton pier.

In 1822 the St. George Steam Packet Company launched two large and powerful steamers, the *St. Patrick* and *St. George*, for the trade between Liverpool and Dublin, and a few years later their *Sea-Horse* sailed weekly between Hull and Rotterdam. The Original Steam Packet Company also ran the *Waterloo* and the *Belfast* on this route. A third company was now projected. Mr. C. W. Williams of Dublin came over to Liverpool to seek financial support for his project of building steamers for the same route. Failing at Liverpool, he returned to Dublin and met with such encouragement that in the following February he came back to Liverpool, and placed an order with Wilson, popularly called "Frigate Wilson," the leading shipbuilder of his time on the Mersey, for the first steamer of what was destined to become one of the most famous steamship companies in the world, the City of Dublin Steam Packet Company. This vessel, the *City of Dublin*, was to be constructed to carry general cargo besides livestock and passengers, and to maintain the service throughout the year. She was probably the first steamer designed to

THE "SEA-HORSE." ABOUT 1826.

p. 72

carry both passengers and cargo. Williams saw that it was as much to the interest of merchants to have their goods delivered with regularity as it was to the interest of passengers to reach their destinations punctually.

Merchants were equally quick to see the advantages of punctual delivery, and the Williams enterprise prospered. The following month he contracted with Wilson for the building of the *Town of Liverpool*, there being some delay in placing this contract as Wilson had just contracted to build the steamer *Henry Bell* for the Liverpool and Glasgow trade. The *City of Dublin's* maiden voyage was made on March 20, 1824.

Meanwhile the Dublin and Liverpool Steam Navigation Company had been founded, and started trading operations in September 1824 with the steamer *Liffey*. In December of the same year the *Mersey* was added, and in 1825 the *Commerce*. The last named was the largest vessel so far employed in cross-channel traffic. She was built at Liverpool by Messrs. Grayson and Leadley.

The competition among the companies was exceedingly keen, and increased as they added to their respective fleets. The City of Dublin Company paid little heed to what was known as the Original Company, but found its work cut out in competing with the other two. The first really serious rate war broke out, and seems to have spread to the steamer companies in the Scottish and North of Ireland passenger trade.

Not content with cutting rates to vanishing-point, the northern rivals indulged in lively newspaper polemics in the shape of advertisements, which praised their own boats and gave the lie direct to the manifestos of their opponents. The owners of the *Swift*, sailing from Glasgow, advertised the "great superiority" of their vessel "over the cock boat that is puffed off as sailing direct from the Bromielaw." "For the sake of strangers coming

from a distance it may be proper to state that her power and size are double, and her speed so much greater, that when the two vessels start together the *Swift* runs the other out of sight in five or six hours."

The *George Canning* was the vessel referred to in this contemptuous manner and her owners retorted in kind. Their advertisement referred to the "contemptible article in the *Swift's* advertisement" as "stating a gross falsehood knowing it to be such." The *Swift* is challenged to produce a single instance of ever having accomplished her passage from Belfast in so short a time as the *George Canning*, and the public are informed that the two have never yet sailed together either from Belfast or Glasgow, and the *Swift* is asked when and where she ran the other out of sight.* So matters went on until the *Swift* was sold to the London, Leith, and Edinburgh Shipping Company in 1826. The companies actually carried saloon passengers from Belfast to Glasgow for 2*s.* a head; second cabin passengers went for 6*d.*, and deck passengers went free.

The war on the Liverpool and Dublin route ended in the Liverpool Companies carrying saloon passengers for 5*s.* and steerage passengers for 6*d.* each, one of the vessels conveying on one voyage seven hundred steerage passengers at that fare.

Negotiations between the City of Dublin Steam Packet Company and the Dublin and Liverpool Steam Navigation Company followed, by which the former purchased the Navigation Company's steamers. They had then a fleet of fourteen vessels and entered upon a long career of prosperity, chequered by occasional battles with rival companies. A rate war with the Langtry Company of Belfast ended in the steerage fare between Liverpool and Belfast being reduced to 3*d.*, including bread and meat. For a time, too, there was rivalry between the Dublin Company and the Waterford Commercial Steam

* *Glasgow Herald*, June 30, 1825.

Navigation Company, which in 1837 joined in the trade between that city and Liverpool with the iron paddle-steamer *Duncannon*, of 200 tons, built by Laird of Birkenhead. This was probably the first iron steamer built for the cross-channel service, but by no means the first to be seen in Irish waters.

While the companies were struggling, passengers were even carried free between Liverpool and Waterford, and sometimes between Liverpool and Dublin. "A story is told of a passenger going into the Dublin Company's office at Waterford, and inquiring the cabin fare to Liverpool. He was told he would be taken for nothing, to which he replied, 'That is not good enough, you must feed me as well.'" There is a tradition also that when one of the rival companies of the Liverpool and Dublin service "advertised its willingness to carry passengers for nothing, and to give them a loaf of bread, the other company capped the offer by the addition of a bottle of Guinness' stout."* The fight continued for three years, until the City of Dublin and the Waterford Company came to terms. This settlement brought about peace between the Belfast and the British and Irish Companies, the former sharing the Liverpool and Belfast trade with the Cork Company, while the British and Irish Company shared the London and Dublin trade with the Waterford Company. This truce continued for several years, but the war had sent nearly all the Waterford trade to Liverpool, to the detriment of the line running between Waterford and Bristol. A dispute followed between the Waterford and Bristol Companies and was maintained until the Bristol Company bought off the Waterford Company with an annual subvention of one thousand pounds.

The increase in the number of steamers from 1820 onwards was extraordinary. In 1825, forty-four steamers were building at London and Liverpool alone, with tonnages

* Kennedy's "History of Steam Navigation."

varying from 250 to 500. Most of these vessels were built for the coastal service, the only international voyages being between the British coast, France, and the Netherlands. In 1818, according to Dodd, steamers were employed on the Clyde in the conveyance of merchandise, though for the most part vessels propelled by the new invention, as it was generally called, were confined to passengers, the goods being sent by sailing boats. In 1820 and 1821 no steamers were employed in the foreign trade, but in 1822 it appears that the entrances inward of steamers engaged in the foreign trade numbered 159, with a tonnage of 14,497, while the clearances numbered 111 with a total of 12,388 tons. The coasting trade in that year for the United Kingdom was 215 vessels entered inward, with a tonnage of 31,596, and the clearances numbered 295 with an aggregate tonnage for the year of 42,743. The year 1823 saw a falling off in the entrances and clearances in the foreign trade, but in the following year there was a partial recovery which was continued in 1825; and in 1826 the number of entrances of steam vessels was 334, with an aggregate tonnage of 32,631, the clearances being 268 with a tonnage of 27,206. In that year also the coasting trade showed 2810 entrances of 452,995 tons, and 3833 clearances of 518,696 tons. By 1828 the coasting entrances rose to 5591, with an aggregate of 914,414 tons, with 6893 clearances and an aggregate tonnage of 1,009,834. French-owned steamers first appeared in the United Kingdom records in 1822, when there were ten entrances of 520 tons altogether. In 1823 the entrances from France had shrunk to seven, of a total of 364 tons, and the clearances were the same; but by 1827, 74 entrances of French steamers are recorded, and 43 clearances.

In 1829 Holland appears for the first time in the list with one steamer entered and cleared. But in 1830 the steamer traffic between the two countries had grown so

that the entries of Dutch steamers numbered twenty-three, with an aggregate of 6463 tons, and the clearances thirty-two with 8992 tons. By 1836 the entries in the United Kingdom coastal trade were 13,003, with an aggregate tonnage of 2,238,137, and the clearances 12,649 with an aggregate of 2,178,248 tons. In 1837 Belgium, France, and Spain figured in the returns, and in 1838 Portugal and Brazil. Russia and Turkey were added to the list in 1839. In that year the United Kingdom coastal entries numbered 15,556 of 2,926,521 tons, and the clearances 15,498 of 2,894,995 tons. These figures do not include vessels in ballast nor those with passengers only.

The report of the Commissioners appointed by the Privy Council in 1839 to inquire into steamship accidents, shows that some laxness prevailed in regard to registration, no fewer than 83 unregistered steam vessels being discovered, most of which were in the passenger trade; thirty-seven of these were on the Mersey, sixteen on the Thames, twenty-six on the Humber, and four on the rivers on the east coast of Scotland. The Commissioners added that there were probably many others unregistered, as they did not visit all the ports.

On the other hand, there were only twenty-five registered steamers on the Humber, Ouse, and Trent, and thirty-nine at Liverpool. Two Liverpool companies owned more vessels than the total number registered there. The Commissioners found that nineteen-twentieths of the large number of trading steamers between Ireland and Liverpool, some of which were registered in English and some in Irish ports, were owned in Ireland. The report further stated that of the 766 steam vessels tabulated as belonging to Great Britain, Ireland, the Isle of Man, Guernsey, and Jersey, 484 might be considered as river steamers and small coasters, and 282 as large coasters and sea-going ships.

The total number of registered vessels at the end of

1838 was 677, with a total registered tonnage of 74,510, a total computed tonnage of 131,080, and estimated horse-power 54,361. Unregistered vessels numbered 83 of 9638 tons gross, and 2129 estimated horse-power. The foregoing particulars show how rapidly the number of steamers increased for some years.

Services seem to have been started between almost every two or three ports of the United Kingdom. The little wooden vessels were long-lived, and had some unique experiences owing to the venturesome characters of their captains, owners, or charterers. Provided the vessel would float and get along it seemed to be the opinion of its owners that it could go anywhere and carry anything. Thus a vessel built for river traffic was thought suitable for deep-sea work also. It is not surprising to find that many of the steamers changed hands frequently. They were renamed at every change, and the resulting confusion makes it difficult to trace their history.

It seems fairly certain, however, that accidents were frequent, and it became necessary to devise means of carrying boats which would accommodate at least a considerable number of the passengers if necessary. Regulations as to the compulsory carriage of life-buoys, life-belts, rafts, floating seats, and other contrivances for supporting people in the water did not come into force until many years after. The sole means of safety in the early days of steam navigation were the boats and such wreckage as happened to float if the vessel sank or went to pieces. But most of the steamers were so small, and on their voyages so crowded, that they could not carry nearly as many boats as were required.

The boats were generally carried on the tops of the paddle-boxes. A suggestion which was carried into effect, especially in some of the larger ocean-going steamers, was that the paddle-boxes should be built square and be detachable from the guards, so that if a disaster should

befall the vessel they could be used as boats. This contrivance had numerous disadvantages, not the least of them being the unwieldiness of the paddle-boxes, and the difficulty of managing them when afloat. Another suggestion was that each steamer should carry two large boats of equal dimensions which could be used as the tops of the paddle-boxes. The main advantage claimed for this idea was that it would not add materially to the weight of the vessel. Captain George Smith, in the 'thirties, contrived a peculiarly shaped lifeboat which would fit over the paddle-wheels and take the place of the paddle-boxes, and might when occasion required be turned right side uppermost and launched outside the paddle-wheel. He tried this experiment on the steamer *Carron*. "The upper section," he wrote, "of her paddle-wheel is covered by a lifeboat 25 feet long, 9 feet beam, and having four air-tight cases which may be removed if required on particular occasions. This lifeboat is capable of containing between forty and fifty persons. When in her place over the paddle-wheel the midship thwarts are unshipped, which admits of the wheel revolving within 6 inches of her keelson; she lies bottom upwards on two iron davits, which enable her to be turned over and lowered by six men in two or three minutes."

The early river steamers were often overcrowded, which is not to be wondered at in those days of insufficient control, and a cartoon of the period represents the passengers as hanging on to the rigging, the bowsprit, the funnel, and anything else of which they could catch hold. Complaints of reckless speed and careless navigation were frequent, and the Worshipful Company of Watermen and Lightermen gave orders that the speed should not exceed five miles an hour: but the captains of the Thames steamers were often fined for breaking the rules, as they were in the habit of racing against boats belonging to rival companies. As to overcrowding, the *Times* of April 16, 1838, thus

delivered itself: "It would be as well if some measures be adopted to prevent steamers being overcrowded during the Easter holidays. During the last Easter and Whitsuntide holidays the steamers were crammed with passengers in a fearful manner, the small vessels carrying 500 and 600 passengers at one trip, and the larger ones 1000 and 1500 persons, as closely packed as negroes in the hold of a slave-ship."

By 1846 the rivalry among the companies on the river brought about the usual rate war. The steamers and the Watermen's Company were often at loggerheads, and neither always agreed with the City Corporation. An attack of the City Corporation employees upon those of the Watermen's Company was valiantly resisted, and the watermen went to gaol in consequence. *Punch* commented on this as follows: "Considerable excitement has been occasioned by some experiments which have lately been tried in the Thames navy, on the same principle as that recently applied to the *Bellerophon*, which was got ready for sea in sixty hours, and got unready again with equal promptitude. The Waterman No. 6 took in coals and ginger-beer, manned her paddle-box, lit her fire, threw on a scuttle of coal, filled her boiler, blackleaded her funnel, tarred her taffrail, and pitched her stoker into her engine-room, all within twenty minutes, and sailed away from her moorings at Paul's Wharf amidst the cheers of her checktaker. This manœuvre was accomplished for the purpose of striking terror into the minds of the civic forces at Blackfriars Pier, who are only tranquil at present in compliance with the terms of a recent armistice."

The modern development of the coastal steamer service has naturally been confined to a strict meeting of its own requirements, and it is not proposed to go at length into all the minutiæ of the differences between the steamers of the various lines. Some of the most famous companies have already been mentioned and their early

TRINITY YACHT MONARCH ROYAL GEORGE TRIDENT

p. 80

THE "MONARCH" AND "TRIDENT" (GENERAL STEAM NAVIGATION CO.) CONVOYING THE ROYAL YACHT WITH THE QUEEN AND PRINCE CONSORT TO EDINBURGH, 1842.

struggles with competitors described. In connection with coastal and cross-channel traffic it will now be sufficient to sketch the careers of a few others which have helped to make steam-ship history.

General Steam Navigation Company

To London shipowners belongs the credit of establishing one of the oldest steam-ship companies in the world, the General Steam Navigation Company. It was founded as far back as 1820 and its first steamer, the *City of Edinburgh*, was built expressly for trade between Edinburgh and London by Messrs. Wigram and Green at Blackwall, and was launched on March 31, 1821. Her engines were by Boulton and Watt, and were of 80 horse-power nominal.

A steam-ship of any kind was a novelty at that time, and the launch of such a large vessel on the Thames attracted the attention of all classes. The Duke and Duchess of Clarence, who were afterwards William the Fourth and Queen Adelaide, accompanied by the Duchess of Kent and a large suite, paid a special visit to the wharf to see her. The royal party expressed themselves as much surprised by the magnificence of the accommodation provided for the passengers as by the noble and graceful proportion of the vessel in which such powerful machinery had been placed. The *City of Edinburgh* was followed in June 1821 by the *James Watt*, launched by Messrs. Wood and Co. of Port Glasgow, and at that time described as "the largest vessel ever seen in Great Britain propelled by steam." Her engines were of 100 nominal horse-power, and drove paddle-wheels 18 feet in diameter with sixteen floats, which were 9 feet in length by 2 feet broad.

The company was incorporated in 1824 and then and for many years afterwards occupied a place second to none

in the British mercantile marine as carrier of passengers, mails, goods, and cattle on the leading routes from London to the North, and to the principal commercial ports of Western Europe. The *Earl of Liverpool*, of 168 tons register and 80 horse-power, was built for the company at Wallis's yard on the Thames in 1822.

An early picture of this vessel shows her to have been two-masted, carrying on the foremast three jibs, two topsails, and a trysail, and on the mizzen two enormous flags, one several yards long bearing the name of the vessel, and the other, half the size of her spanker, being the company's house flag, while at the stern she displayed an immense ensign, and at the bows a little Union Jack. Her paddle-boxes were rather forward of amidships, and a tall funnel with a spark-catcher above stood a short distance in front of the mizzen-mast.

In 1833 this company built the *Monarch*, of which a contemporary newspaper says, under the heading "Gigantic Steamboat":

"The dimensions of the *Monarch*, Edinburgh steamer, launched a few days since are as follows:—extreme length 206 feet $1\frac{1}{2}$ inches, width of deck 37 feet, width outside the paddles 54 feet 4 inches, length of keel in the tread 166 feet; length of deck from the stem to the taffrail 193 feet, depth in hold 18 feet. The extreme length given above is within 2 feet of the largest ship in the British Navy; she is larger than any of His Majesty's frigates, and longer than our 84-gun ships. Her tonnage is somewhat more than 1200 tons, and the accommodation below is so extensive that she will make up 140 beds, and 100 persons may conveniently dine in her Saloons."

The *Trident*, built in 1842, was another of the company's famous ships, and was probably the first steam-ship in which a reigning sovereign went for a lengthy sea voyage. Queen Victoria paid her first visit to Scotland and made the return journey from Edinburgh with Prince Albert

THE "TRIDENT," IN WHICH THE QUEEN AND PRINCE CONSORT RETURNED, SEPT. 1842.

p. 82

and their suite on this vessel. An interesting description of the voyage appeared in "Leaves from the Journal of our Life in the Highlands." The Queen remarked of the accommodation on the *Trident* "that it was much larger and better than on the *Royal George*," which was the royal yacht of the period, and that it was "beautifully fitted up." The *Trident* soon lost sight of all the accompanying vessels, except the company's steamer *Monarch*, which "was the only one that could keep up with us." Writing a few days later to the King of the Belgians the Queen says: "We had a speedy and prosperous voyage home of forty-eight hours on board a fine, large, and very fast steamer, the *Trident*, belonging to the General Steam Navigation Company."

These vessels, of course, were of wood, but when iron steamers were introduced and paddles gave way to the screw propeller, the company was not slow to see the advantages of the innovations, and to adopt them for its services.

In modern times this company has distinguished itself by its zeal for self-improvement. Every important development in steam-ship construction and engineering has been marked by the company by an addition to its fleet, one of the most recent being the *Kingfisher*, the first steam turbine-driven passenger steamer on the Thames.

London and Edinburgh Shipping Company

Probably on none of the British coasts was the advent of the steamer hailed with more pleasure than on the east coast. Travel between London and the east of Scotland, before railways were possible, and when the land journey had to be made by stage-coach or on horseback, or a sea journey performed in sailing smacks, was a tedious operation. The smacks were large of their sort, and as comfortable as vessels of that period usually were (which is not saying much), but the North Sea was as turbulent then as now,

so that passengers who went down to that part of the sea in smacks usually had an experience which lasted them a lifetime.

The London and Leith service of the present day is maintained by a line of steamers as good as any on the coast. The existing company was not the first to trade between the two ports whence it takes its name, but its history connects it with the earliest attempts to found a regular service between the English and Scottish capitals. This was established in 1802 by the old Edinburgh and Leith Shipping Company, with six smacks. About seven years later there was established a London and Edinburgh Shipping Company, which possessed ten smacks. There had previously been a Leith and Berwick Company, so called because Berwick was a port of call between the Forth ports and London. This was the Union Company, which for fifty years previously had traded from Berwick. It was absorbed by the London and Leith Shipping Company in 1812, and this combination was joined by another in 1815. The existing company is the lineal descendant of the combination of the three.

Before steam was used "it was not an uncommon experience," says an historical publication issued by the London and Edinburgh Shipping Company, "for a smack to lie windbound in the roads for days before venturing out of the Forth, and instances were more than traditional of a smack with a cabin full of passengers being tossed about on the North Sea for days or weeks, and then forced to come back to Leith for the replenishment of stores, without having been any nearer to London than when she set out." On one occasion a smack in which there were seven cabin passengers was nine days at sea, the year being 1825, and the month March. Upon leaving Leith for London and getting well into the North Sea they were driven towards Norway for four days, when a "welcome change of wind set in, which drove them

THE "CARRON" (CARRON CO.).

THE "KINGFISHER" (GENERAL STEAM NAVIGATION CO.). p. 84

back towards Scotland with equal rapidity." Having sighted the Bell Rock they continued the voyage to London, and made a good run in spite of the loss of some spars and canvas. The passengers were "unhappy" and at times were not allowed on deck for fear of being washed overboard. Another smack was three weeks endeavouring to get to London and then had to return for more stores. Prior to the smacks the voyages were usually made by brigs of anything between 160 to 200 tons, which sailed when their owners thought they had enough cargo and passengers aboard.

Presumably no one sailed by smack who could afford to coach between Scotland and London, but the coach fare in 1824 was £13 and the smack fare £4. Passengers by smack had a fair chance of witnessing a sea-fight, during which the ladies would be locked up in the cabin while the martially-inclined among the passengers might be called upon to assist the crew in repelling the attack of a French privateer. The smacks were superseded by the celebrated Aberdeen schooners or themselves converted to that rig, and the schooners bravely upheld the reputation of sail as long as possible against the all-conquering power of steam. But in 1850 the company introduced steam and the fine clippers were withdrawn. It is this company's proud boast that it has never lost a passenger.

The Carron Company

The Carron Company, manufacturers of iron goods, maintained a passenger service between Carron and London with sailing sloops long before steam-ships were invented. So long ago as 1779 the company advertised in the *Edinburgh Advertiser* as follows:

At CARRON—For LONDON.

To fail March 5, 1779.

THE GLASGOW, Robert Paterfon mafter, mounting fourteen twelve pounders, and men anfwerable. For freight or paffage, apply to Mr. G. Hamilton, Glafgow, Meff. James Anderfon & Co. Leith, or the Carron Shipping Company at Carron Wharf.

N. B. The Carron veffels are fitted out in the moft complete manner for defence, at a very confiderable expence, and are well provided with fmall arms. All mariners, recruiting parties, foldiers upon furlow, and all other fteerage paffengers who have been accuftomed to the ufe of fire arms, and who will engage to affift in defending themfelves, will be accommodated with their paffage to or from London, upon fatisfying the mafters for their provifions, which in no inftance fhall exceed 10s. 6d. fterling.

The Carron veffels fail regularly as ufual, without waiting for the convoy.

As the sloops carried the company's famous carronades there can be no doubt that they were well armed. The company can boast a more ancient connection with steam-ship building than any other firm in the British Isles, for they constructed the hull for one of the Miller boats and assisted in the construction of one of Symington's engines. Miller is reported to have examined Symington's engines at the Carron works. The company soon ran steamers instead of sailing vessels along the east-coast route and have continued to do so up to the present day, the latest additions to their fleet being the *Thames* by A. and J. Inglis, and the *Carron*, 308 feet long, which has her steering gear fitted aft at the rudder head and controlled by hydraulic action on the telemotor principle.

An interesting fact in connection with the Carron Company is that the first set of complete castings for James Watt's steam-engine were made at their works, and were erected at the house of Dr. Roebuck, who was one of the founders of the company and a personal friend of Watt. A part of the cylinder of this engine marked "Carron 1766" is still preserved at the works. John

THE "FINGAL" (LONDON AND EDINBURGH SHIPPING CO.).

THE "LADY WOLSELEY"
(BRITISH AND IRISH STEAM PACKET CO.)

p. 86

Smeaton, of Eddystone Lighthouse fame, was also associated with the Carron works.

Dundee, Perth and London Shipping Company

This company dates, like others on the east coast, from the time when the voyage between the Thames and Scotland was only performed by sailing smacks, and of these they ran nineteen. But in 1834 the smacks were removed and paddle-steamers took their place. Their first steamers were the *Dundee* and the *Perth*, each boat having a commander as well as a sailing master. They were wonderful vessels for the time, being of 650 tons burden and 300 horse-power. They were advertised as "these splendid and powerful steamers"; the cabins were "airy, commodious" (epithet beloved of steam-ship companies), and "elegant." The company's present-day fleet consists of the *London* and the *Perth*, each of 1737 tons and 3000 horse-power.

Isle of Man Steam Packet Company

No steamer company holds a more honourable position in the coastal and passenger trade than the Isle of Man Steam Packet Company. The vessels in early years were known as "the little Cunarders," a compliment which they well deserved. The appearance of the vessels of the two companies was much the same, and the red and black funnel has always been a distinguishing feature of both lines. The first boat of the Isle of Man Company was built by John Wood of Glasgow in 1830, and named the *Mona's Isle*, a title which has been borne by more than one distinguished successor. She was schooner-bowed, and carried on her paddle-boxes, which were placed well forward, the familiar three-legged sign of Manxland. The engines of the first Cunarder built for the trans-

atlantic service were by Napier, who also built the hull, and this steamer was to all intents and purposes a large edition of the *Mona's Isle*, whose engines he had previously built. Her dimensions were 116 feet in length by 19 feet beam, with a depth of 10 feet, and 200 gross tonnage. She cost £7042, and when sold in 1851 after twenty-one years' service, in which she proved a most profitable vessel, she fetched £580.

But the first steamer seen in Manx waters was the *Henry Bell*, named after the constructor of the historic *Comet;* she was on her way from the Clyde to Liverpool to be placed on the service between Liverpool and Runcorn and put in at Ramsey Bay. In May of the following year the *Greenock* arrived at Douglas, whence she took some passengers to Laxey, and, as a local chronicler puts it, "moved by apparent enchantment." The *Mona's Isle* was thought to be too large and valuable to risk being used in winter, and a smaller boat was therefore ordered from the same builder. This was the *Mona*, and after her arrival in July 1832, she was engaged in a service between the island and Whitehaven and in taking visitors on trips round the island. Even before the advent of the steamers, the Isle of Man had become a favourite place at which to spend the summer, especially among the people of the north and west counties. If affection for the island could induce so many hundreds of people to brave the discomforts of a voyage from the Mersey to Douglas and back again in the small sailing packets which then were the means of communication, it is little wonder that the advent of the steamers, restricted in dimensions as they were, poor in accommodation, and slow travellers, should have increased her popularity. Occasionally the sailing packet took as long as a week to make the trip, and it was hailed as an extraordinary circumstance that a vessel trading between Douglas and Whitehaven was able

THE "BEN-MY-CHREE" (I.). BUILT 1845.

p. 88

to make fifty-two voyages each way in the course of a year. In 1813 also, a sailer took three days and nights to get within sight of Liverpool, and was then driven back by stormy weather to the island.

The *Mona* had one mast on which she could carry a jib, a forestay-sail, a mainsail, and a topsail, and her funnel was abaft the paddle-boxes, which were amidships. She was faster than her predecessor, and usually did the journey between Liverpool and Douglas in about seven and a half hours. She once reached Whitehaven from Douglas in a trifle over four and a half hours, which was claimed to be one of the fastest pieces of travelling on record. The *Queen of the Isle*, which was the company's third ship, was the fastest vessel afloat at the time. These three boats, according to a bill issued in 1834, were known as the Royal Mail and War Office steam-packets, though they never had any connection, so far as the company has been able to ascertain, with the War Office. A Liverpool firm purchased the *Mona* in 1851 and sold her to the City of Dublin Company, who ran her for several years, until she was hopelessly outclassed in size and accommodation by newer boats. She was then used as a tug, and so spent the remainder of her days.

The first steamer ordered by the company to be built in the island was the first *King Orry*, by John Winram, with engines by Robert Napier. This boat was the last of the company's wooden paddle-steamers. She was a very reliable boat but not particularly fast, for she usually took about seven hours for the trip each way. In 1843 the *Queen of the Isle* was relieved of her engines, sold, and turned into a full-rigged sailing ship and met her fate off the Falkland Islands.

The *Ben-my-Chree*, a three-masted schooner, the first of the company's steamers to be built of iron, was fitted with the *Queen of the Isle's* engines. The *Tynwald*, a larger steamer still, followed in 1845, and was

herself followed by the *Mona's Queen*, a rather smaller vessel but faster, and bearing a figure-head which the carver said was a likeness of Queen Victoria; be that as it may, the vessel was named in commemoration of the visit of the Queen to the island in 1847.

Hitherto the company's steamers had been of little more than local interest; the *Douglas* was now ordered and she acquired international fame. This vessel was the first of the Manx boats in which the straight stem was adopted. She was built in 1858; her length between perpendiculars was 205 feet, with a beam of 26 feet and a depth of 14 feet, and a gross tonnage of 700. The *Tynwald*, which was of the same tonnage was 188 feet long, by 27 feet beam, and 13 feet 6 inches depth. The *Douglas* was thus longer in proportion to her beam than any of her predecessors, and being powerfully engined, made 17¼ knots on her trial trip. She did the passage between Liverpool and Douglas in 4 hours and 20 minutes, and was the fastest sea-going paddle-steamer afloat.

The situation at this time between the Northern and Southern States of the United States of America was becoming strained, and there were already indications of the approaching conflict. After four years' service the *Douglas* was sold, through a third party, to the Confederate agents.

In a coat of grey paint, with her upper works altered, carrying two or three guns, and rechristened the *Margaret and Jessie*, the trim Manx boat became one of the most famous blockade-runners the Southern States possessed. Her career was brief, but exciting. In 1863 she was sighted off Abaco by the Federal steamer *Rhode Island*, which chased her to Eleuthera in the Bahamas and fired upon her when she was only 250 yards off shore. Shot and shell were rained at her by the gunboat, many of the missiles passing beyond the fugitive and striking

THE "TYNWALD" (I.). BUILT 1846.

p. 90

the shore. At length a shot penetrated her boiler, and another struck her bows so that she had to be beached. This is her last recorded exploit. Contradictory stories are told of her. One states that she was patched up, refloated, and became a peaceful trader among the islands; another, that she was wrecked where she lay; yet another that she resumed her blockade-running under another name, though this may be explained by the fact that blockade-runners often changed their names and disguises, and that one of them may have had a name somewhat similar; and a fourth story is that she was turned into a sailing schooner and ultimately became a coal-barge.

The next boat built by the company was the no less famous *Ellan Vannin*, first named the *Mona's Isle*. She was an iron vessel built in 1860. Her dimensions were: length 198 feet 6 inches, breadth 22 feet 2 inches, depth 10 feet 7 inches, with a gross tonnage of 380. Her indicated horse-power was 600 and her nominal horse-power 100. She averaged about 12 knots. She was lost with all on board at the mouth of the Mersey in the terrible gale of November 1909. She was originally a paddle-boat, but was converted into a twin-screw steamer in 1883, and was then renamed the *Ellan Vannin*. Her regularity of passage and her immunity from accident were as noteworthy under her new conditions as under the old, and until she ended her career under circumstances which make her loss one of the most remarkable mysteries of the shipping of the port of Liverpool, she was looked upon as the mascot of the fleet.

Three years later the *Snaefell* was ordered; she was 326 feet in length, by 26 feet beam, with a gross tonnage of 700, and was propelled by engines of 240 nominal horse-power. She brought down the passage from Douglas to Liverpool to 4 hours 21 minutes.

The Royal Netherlands Steamship Company, being in want of a fast steamer for the conveyance of the mails

between Queenborough and Flushing, bought the *Snaefell* and afterwards chartered the second *Snaefell* built in 1876, of rather larger dimensions, and with a gross tonnage of 849, and engines of 540 nominal horse-power and 1700 indicated, capable of driving her at an average speed of 15 knots. In 1871 the second *King Orry* was built. She was 290 feet in length by 29 feet beam, with a depth of 14 feet 7 inches, and of 1104 gross tonnage, and was much the largest steamer the company had possessed up to this time. Her engines were of 622 nominal horse-power, and 4000 indicated, and her speed was 17 knots. Her original length was 260 feet, and another 30 feet were added in 1888. The second *Ben-my-Chree* was built to the order of the company in 1875, and was 310 feet in length, 1192 gross tonnage, and with a speed of 14 knots. She was the only passenger vessel for some time in the British Isles to be fitted with four funnels, two of which were carried before and two abaft the paddle-boxes. From this peculiarity of her construction she was known to her patrons and to the west of England shipping people as the floating coach-and-four. What advantage was gained by the four funnels is not known, for they held a lot of wind.

The second *Mona*, a much smaller vessel, followed in 1878 and was the first of the company's fleet to be fitted with a screw. Three years later the *Fenella*, which in its general dimensions was almost a sister ship to the second *Mona*, was built and was the first to be fitted with twin screws. She was so successful that the conversion of the *Mona's Isle* into a twin-screw boat followed. The company returned to paddle-wheels for their next vessel, the third *Mona's Isle*, which was the first to be built of steel, of which material all the company's subsequent boats have been constructed. The *Mona's Isle* was 330 feet 7 inches between perpendiculars, 38 feet 1 inch beam, 15 feet 1 inch depth of hold, and of 1564 gross tonnage.

THE "MONA'S ISLE" (II.). BUILT 1860 AS A PADDLE STEAMER.

p. 92

Her engines were of 1983 nominal horse-power, and 4500 indicated, and her speed was 17½ knots. Two years later the little *Peveril* was launched, also bearing a name of historical association in the island. She was the company's first steel twin-screw boat, and was lost in September 1899, not far from where the *Ellan Vannin* went down. The second *Mona's Queen*, only slightly smaller than the second *Mona's Isle*, followed in 1885, and in 1888 the sister vessels *Prince of Wales* and *Queen Victoria* were added to the fleet.

They were each 330 feet between perpendiculars, 39 feet 1 inch beam, 15 feet 2 inches depth of hold, with a gross tonnage of 1557. The engines of each were of 925 nominal horse-power, and of 6500 indicated, and their average speed was 20½ knots. Both these were paddle-vessels. The third *Tynwald* was launched in 1891, and is a twin-screw ship. The *Empress Queen*, the biggest paddle-steamer the company ever possessed, was ordered in 1896 from the Fairfield Company. She is 360 feet 1 inch between perpendiculars, 42 feet 3 inches beam, and 17 feet depth of hold. Her gross tonnage is 2140; her engines, of 1290 nominal horse-power and 10,000 indicated, gave her then a speed of 21½ knots, which has since sometimes been exceeded. The third *Douglas* and the third *Mona* call for no special comment, except that the former was the *Dora* of the London and South-Western Railway, from which the Manx Company purchased her in 1901, and that the last-named steamer was the last paddle-boat ordered by the company. The directors in 1905, finding the need of newer and faster vessels, ordered the steamer *Viking*, propelled by triple screws driven by turbine machinery, and so successful was she that the third *Ben-my-Chree* was added in 1908.

It may be questioned if any other of the coasting companies presents in its vessels such an illustration of the development of steam-ships and steam-engines, from the

insignificant little tubs no bigger than river barges to the latest examples of the shipbuilder's art.

The opposition which the Manx Company has had to fight has been severe. Its first steamer, the *Mona's Isle*, on her first voyage found herself pitted against the *Sophia Jane*, the boat which afterwards made the first steam voyage to Australia. It would be more correct to say that in this case the *Mona's Isle* was the opposition boat, as the *Sophia Jane*, which belonged to the St. George Company, was already on the service. The older boat got in first by something less than two minutes. But new steamers seldom attain their best speed at first, and the newcomer soon developed such speed that the old boat was left behind on every voyage afterwards in which they competed, and once came in after a rough trip three and a half hours behind. The rivalry resulted in the usual rate war, and the St. George Company brought its fares down to 6*d*. single. But neither this step nor the placing of the splendid steamer *St. George* on the service did the Manx Company any harm. The first race between their vessels was remarkable for an ingenious piece of seamanship on the part of the commander of the *Mona's Isle*. The little paddle-boats of those days usually felt a strong beam wind to such an extent that the paddle on the windward side would be out of the water half of the time, and that on the lee side half buried owing to the boat heeling over. The captain, judging that the dirty weather which then prevailed would continue next day, spent the night before the race in shifting the cargo and coal on board his boat to the windward side. When the two vessels left the Mersey in the morning the *St. George* was in beautiful trim, and the Manx boat was leaning over on one side in a fashion which caused those who did not understand what had been done to laugh at her. When the open sea was reached it was the *St. George's* turn to heel over before the gale, and the *Mona's Isle*

THE "ELLAN VANNIN" (THE FOREGOING ALTERED TO A SCREW STEAMER AND RENAMED, 1883).

p. 94

went along practically on an even keel, using both her paddles to the best advantage, while the *St. George* had one nearly buried and the other beating the air uselessly much of the time. Of course the *Mona's Isle* won. This incident is interesting as it shows the daring nature of the expedients which the captains of the little steamers of those times were prepared to adopt.

This rivalry was destined to end in the wreck of the *St. George.* The Manx captain, having probably a better knowledge of local conditions than the commander of the *St. George*, foresaw that a south-easterly gale was rising, which always blows inshore at Douglas. As soon, therefore, as he landed his passengers he put to sea again, but the *St. George* was anchored in the bay, and during the night as the gale freshened she was blown on the Connister Rocks and went to pieces. All on board were saved by the Douglas lifeboat, whose captain was one of the founders of the Royal Lifeboat Institution. The St. George Company maintained the opposition for a little while longer, until another vessel, the *William the Fourth*, was lost. They then retired from the service altogether.

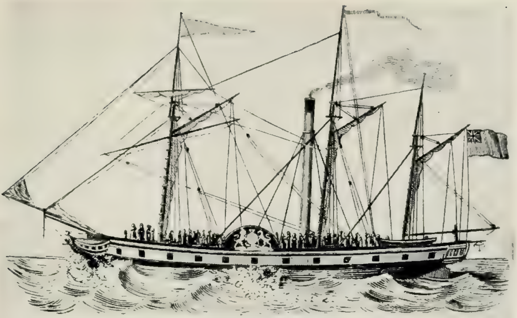
The St. George Company was itself an opposition line at first to that established by Messrs. Little and Co. ; but the last-named firm have maintained their steamship connection with the island until within the last few years. It is little wonder that the Manx Company was started to supersede the St. George Company, for the latter, having no opposition during the winter months, used for that station its slowest and smallest boats, which were devoid alike of adequate comfort and shelter for the passengers.

Messrs. James Little and Co.

This firm, which was established as early as 1812, despatched in 1819 the first steamer which ever carried

passengers from the Clyde to Liverpool. This was the *Robert Bruce*, a small vessel of 98 feet in length; she was soon followed by the *Superb*, and in 1820 by the *Majestic*, and two years later by the *City of Glasgow*. The steamers on the Liverpool and Glasgow service called at Port Patrick and Douglas, and in 1828 Messrs. Little inaugurated their Glasgow and Belfast service with a new vessel, the *Frolic*. It was for this service also that some years later they ordered, from Messrs. Denny and Co. of Dumbarton, the *Waterwitch*, which was the first screw steamer built on the Clyde. Another of their most notable boats was the *Herald*, a Clyde paddle-steamer, built in 1866 and placed by them on the Barrow and Isle of Man service the following year. They afterwards added those fine steamers *Manx Queen*, *Duchess of Devonshire*, and *Duchess of Buccleuch*, which were so successful that the rivalry between them and the Isle of Man Steam Packet boats became very keen, the Barrow route to the Isle of Man being shorter than the Liverpool.

The evident popularity of the Isle of Man services has proved a sore temptation to speculators to start rival lines to those already in existence. The Isle of Man Steam Packet Company had a virtual monopoly of the Liverpool and Manx service for close on half a century, but in 1887 two large and fast paddle-steamers, *Queen Victoria* and *Prince of Wales*, each of 1657 tons, built by the Fairfield Company for the Isle of Man, Liverpool, and Manchester Company, were started in opposition. Both vessels are stated to have done the journey in a trifle over three hours, and the *Prince of Wales* once accomplished it in under the three hours. After another season's conflict the two boats were bought by the Manx Company. Another opposition company tried its fortunes for a season with the *Lancashire Witch*, a twin-screw steamer, which now, under the name of the *Coogee*, belongs to



THE MAJESTIC,

Captain OMAN,

AND

THE CITY OF GLASGOW,

Captain CARLYLE,

Sail from **GREENOCK** every **MONDAY, WEDNESDAY,** and **FRIDAY,** at One o'Clock in the Afternoon, and from **LIVERPOOL,** every **MONDAY, WEDNESDAY,** and **FRIDAY,** at Ten o'Clock in the Forenoon, calling off **PORT PATRICK,** and at **DOUGLAS, ISLE OF MAN,** both in going and returning from **LIVERPOOL.**

These Packets carry no Goods, being expressly fitted up for the comfort and accommodation of Passengers.

FARES.

For the First Cabin, including Provisions and Steward's Fees.

	To Port Patrick.	*To Isle of Man.*	*To Liverpool.*	*To Greenock.*
From GREENOCK, - -	£1 1 0	£1 10 6	£2 5 0	£0 0 0
PORT PATRICK,	0 0 0	1 1 0	1 11 6	1 1 0
ISLE OF MAN,	1 1 0	0 0 0	0 17 6	1 10 6
LIVERPOOL, - -	1 11 6	0 17 6	0 0 0	2 5 0

For the Second Cabin without Provisions.

	To Port Patrick.	*To Isle of Man.*	*To Liverpool.*	*To Greenock.*
From GREENOCK, - -	£0 10 0	£0 10 0	£0 10 6	£0 0 0
PORT PATRICK,	0 0 0	0 10 0	0 10 6	0 10 0
ISLE OF MAN,	0 10 0	0 0 0	0 9 6	0 10 0
LIVERPOOL, - -	0 10 6	0 9 6	0 0 0	0 10 6

Children under Twelve Years of Age Half Price.

ON DECK.

A COACH, - - - - - - - - - -	£4 15 0	A HORSE, - - - - - - - - - -	£2 10 0
A CHAISE, - - - - - - - - - -	4 0 0	DOGS, per couple, - - - - -	0 10 0
A GIG, - - - - - - - - - - - -	2 10 0		

Parcels Forwarded to the Isle of Man and all Parts of England.

The Proprietors will not be accountable for the Delivery of any Parcel of the Value of Two Pounds and upwards, unless entered, and paid for accordingly.

Passengers are put on Board and landed at Greenock, Douglas, and Liverpool, free of expence.

The Passage between Greenock and Liverpool is generally made within Twenty-five hours.

May **1, 1826.**

JAMES LITTLE, *Agent*, *Greenock*,

"THE MAJESTIC."

the great Australian shipowning firm, the Huddart Parker and Co. Proprietary, Ltd. There have been several other attempts at opposition with boats neither so fast nor so comfortable as those of the established company.

The British and Irish Company, etc.

In 1836 the British and Irish Steam Packet Company was inaugurated. A copy of an old sailing bill of that year makes curious reading. Its reference to the "legal quays" is also interesting as reminding us of a condition of affairs which has now passed away. The "legal quays" were those reserved by the Government for the cross-channel mail steamers, and also those at which special facilities were given to encourage subsidised lines.

This was not, however, by any means the first company to run steamers between Dublin and London, the City of Dublin Company having preceded it by several years, as also did the Cork Steamship Company, and the St. George Company. The first steamers of the British and Irish Company were the *City of Limerick*, *Devonshire*, and *Shannon*, but it would appear from the bill just quoted that the *Devonshire* and *Shannon* gave place to, or were supplemented by, the *Nottingham* and *Mermaid*.

This bill, according to the company's handbook, was issued in 1836. The *Duke of Cornwall*, added to the fleet in 1842, was, like the others, a little wooden paddle-steamer, and schooner-rigged; she was the last of the vessels of this type purchased by the company. Three years later, by which time the superiority of the screw for sea-going steamers had already compelled recognition, the company showed its enterprise by placing two auxiliary screw steamers, the *Rose* and *Shamrock*, on its London and Dublin service, each of them proving an unqualified success. That decade will ever be memorable for the introduction of iron vessels with screw propellers.

In 1850 the company purchased the *Foyle*, one of the finest iron steamers in existence at the time, and in the summer of the next year established its regular service between Liverpool and London, with calls both ways at the intermediate south of England ports. It ran for a year a service between London and Limerick with the screw steamer *Rose*, which was disposed of the next year. Two fine steamers, the *Nile* and the *Lady Eglinton*, were secured in 1852, and the chartering of the latter vessel as a troop and storeship by the Government during the Crimean War, and the wreck of the *Nile* off Cornwall, caused the cessation of the company's London and Liverpool service.

An interesting connection between the company and the transatlantic service is found in the history of the invariably unsuccessful attempts to inaugurate a service between Galway and America.

The *Lady Eglinton* made two trips between the Irish port and the St. Lawrence in 1858. This vessel was lengthened in 1865 by 30 feet. One of the company's boats, a little paddle-steamer named the *Mars*, which maintained a local service between Dublin and Wexford, was a good sea-boat, and sufficiently speedy for her size to attract the attention of the agents of the Confederate States of America, who purchased her for use as a blockade-runner. In this she was fairly successful for some little time, but accounts differ as to what became of her. It is stated that a blockade-runner of that name was wrecked on one of the keys off Florida in endeavouring to escape from a Federal gunboat. Another version is that the *Mars* received a hostile shell between wind and water, which exploded inside the ship so that she went down. In 1865 the *Lady Wodehouse* was built for the company at Dublin by the shipbuilding firm of Walpole, Webb and Bewley, who four years afterwards built the *Countess of Dublin*. The year 1870 was one of the most important in the history of the company, for it bought the

THE "LADY ROBERTS"
(BRITISH AND IRISH STEAM PACKET COMPANY).

p. 98

steamers of Messrs. Malcomson's London and Dublin Line, the *Cymba* and *Avoca*, and has since had a monopoly of that service. The *Lady Olive*, of 1096 tons, acquired in 1879, was the last iron vessel the company had built; all the succeeding vessels have been of steel.

The engines of the earliest boats were of the usual side-lever type. These in time gave place to compound engines, and the modern steel vessels have triple-expansion engines. The present fleet consists of the *Lady Olive* and the *Lady Martin*, of 1365 tons gross, the latter, built by Messrs. Workman and Clark at Belfast in 1888, being the company's first steel ship. The *Lady Hudson-Kinahan*, of 1375 tons, was built by the Ailsa Shipbuilding Company at Troon in 1891, and this company also constructed in 1897 the *Lady Roberts*, of 1462 tons gross, while the *Lady Wolseley* was launched in 1894 by the Naval Construction Company at Barrow.

The Powell and Hough Lines

These, like nearly all of the older coastal lines that were associated with the firm of H. Powell and Co., started with small sailers between Liverpool and London, with calls at the various ports on the south coast. The history of the line has been one of continued progress, and it maintains at the present time a regular service of fast steamers between London and Liverpool, calling at Falmouth, Plymouth, Southampton, and Portsmouth. Its earlier steamers, as was only natural in the then imperfect state of steam navigation, were, compared with the present boats, small, but were fully up to the average of the coasting fleet, and in many cases could not be surpassed by any vessels trading on the coast, or even by some making ocean voyages. The *Augusta*, built in 1856, with a gross tonnage of 188, and 50 horse-power, was a screw steamer, and carried three

masts. On the foremast were square sails. The company's latest vessels are the *Masterful* and *Powerful*. The *Masterful* is of 2600 tons and is built of steel throughout, and the *Powerful* is of 2200 tons; the improvement in their accommodation compared with that of the boats of fifty years ago is as noticeable as is the increase in size. These vessels are two of the few in the coasting trade fitted with submarine signalling apparatus. The Powell Line also has cargo services between Liverpool and Bristol and a number of ports on the south coast, and between Manchester and Bristol Channel ports and certain south-coast ports.

Associated with this line are the steamers of Messrs. Samuel Hough and Co., the vessels of the two companies sailing as a rule alternately.

Alexander Laird and Co.

The St. George Company withdrew from the Clyde and Mersey trade in 1822, and in 1823 Alexander Laird and Co. began the Liverpool, Clyde, and Isle of Man service with the steamer *Henry Bell*, built by Wilson of Liverpool. In 1824 Mr. Laird placed on the Glasgow and Liverpool service the *James Watt*, which had been a couple of years with the General Steam Navigation Company. She was rigged as a three-masted schooner, and had the distinction of being the first steamer entered at Lloyd's. Laird's service between Glasgow and Inverness was started in 1825, and in the following year the sailings were changed from fortnightly to weekly.

In 1827 Messrs. T. Cameron and Co. started a service of steamers between Glasgow and the north and west of Ireland, but in 1867 it was taken over entirely by Messrs. Laird and Co.

The *Northman* (1847) and *Irishman* (1854) were

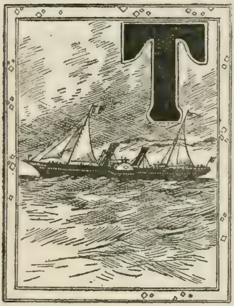
THE "AUGUSTA" (POWELL LINE, 1856).

p. 100

among the earliest iron steamers built; they belonged to the Glasgow and Dublin Screw Steam Packet Company, under which name Messrs. Cameron ran a service between those ports and were opposed by the Sligo Steam Navigation Company until an arrangement was made between Laird's and the Sligo Company. The *Irishman* was the last steamer to carry the white funnel with a black top which was the distinguishing-mark of the old St. George Company. Other vessels of increasing size and importance were added from time to time and the Laird Company's fleet now comprises twelve ships, of which the latest is the *Rowan*, a beautiful steel vessel of about 1500 tons, launched in 1909.

CHAPTER IV

RAILWAY COMPANIES AND THEIR STEAM-SHIPS



THE railway companies early saw the advantages to be gained by the addition of steam-ship services to and from the ports to which their lines ran. Steam-ship owning by the railway companies was not permitted by Parliament at one time, and the proposal, whenever brought forward, was strongly opposed by the private steam-ship owners. The first company to enter the field was probably the North Lancashire Railways, which were subsequently absorbed by the London and North-Western Railway Company, and which, in conjunction with the City of Dublin Steam Packet Company, instituted in 1844 a steam-ship service between Fleetwood and Dublin, the *Hibernia* being the first steamer employed for the purpose. The venture was a success and brought to the Dublin Company such an immense increase in its trade between England and Ireland that in the following year the directors decided to add to their line three auxiliary screw schooners and five paddle-steamers.

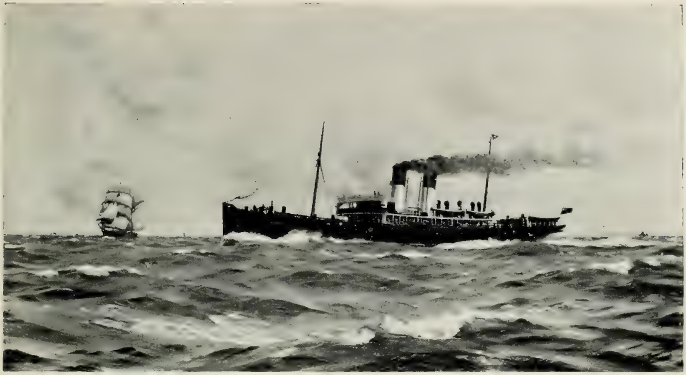
In 1839, the Government arranged that the mails should be despatched every morning and evening from Liverpool to the Irish capital, via Kingstown, on the arrival of the mail trains from London. The morning service was by Admiralty steam packet and the evening

service by the boats of the Dublin Steam Packet Company. The strong rivalry which immediately sprang up between the two services was intensified by the agreement between the North Lancashire Railways and the City of Dublin Company, and resulted in a vast improvement being effected in the steamers employed. For ten years this battle of the services was waged with unabated vigour on both sides, but finally in 1850 the Admiralty withdrew their steamers and left their rivals in full possession of the carriage of the Irish mail service.

The Dublin Company was not, however, long permitted to enjoy the fruits of their well-earned victory over the Admiralty, but was almost immediately involved in a similar conflict with the Chester and Holyhead Railway Company, this time over the conveyance of the mails from Holyhead to Dublin. Recognising the importance of Holyhead as a port, the directors of the Dublin Company had not only placed some of their vessels there, but had also put in a tender for the Trans-Irish Channel mail service, which was accepted by the Admiralty. The Chester and Holyhead Railway Company, who were also steamship owners, were under the impression that no one could compete with them, and believing that they could obtain their own terms from the Admiralty neglected to tender. Prior, however, to the ratification by the Government of the Admiralty's acceptance of the City of Dublin Company's tender, the railway company, by some means best known to itself, obtained information of what was going on and used every means in its power to bring pressure on the Government to prevent the conclusion of the contract. These efforts were so far successful that fresh tenders were asked for by the Admiralty. From the facts which have since been made public, it would appear that the Dublin Company were not at all fairly treated in the first instance, because the amount at which they tendered having been allowed to leak out, the Chester and Holyhead

Railway Company was enabled to undercut them. Fearing that similar tactics might be employed on the second contract, the Dublin Company, in consideration of the importance of the issue involved, put in at a very much lower figure than on the former occasion, secured the contract, and without loss of time inaugurated their new service. Further complications ensued owing to the persistent attempts made by the Chester and Holyhead Railway Company to wrest the contract from their opponents. They, however, were unsuccessful and the matter was finally settled in favour of the Dublin Company by the appointment of a Parliamentary Committee, which reported in favour of the arrangements already made.

Before many of the railway companies became steam-ship owners they made working arrangements with existing steam-ship lines. This method of dealing with the passenger, coasting, and over-sea traffic was due, not to any lack of initiative on the part of those responsible for the management of the railways, but to the uncompromising antagonism of the steam-ship companies, who objected to the railway companies being permitted to own steamers. A Bill empowering the Chester and Holyhead Railway Company to purchase and work steamboats was brought before Parliament in 1848, but was strongly opposed by the steam-ship companies on the ground that it would create undue competition and would interfere with their existing rights, and further, that over-sea competition was outside the legitimate sphere of a railway company's operations. The directors and large shareholders of the Chester and Holyhead Company retaliated by forming themselves into a small independent firm to run steamboats between Holyhead and Ireland. The necessary capital was subscribed, and four new iron passenger steamers, the *Anglia*, *Cambria*, *Hibernia*, and *Scotia*, were built. They were each of 589 tons gross, and were 207 feet long, 26 feet beam, and 14 feet in depth, having a



THE TURBINE STEAMER "MARYLEBONE" (G.C. RAILWAY).

THE "CAMBRIA" (L. & N.W. RAILWAY). *p.* 104

draught of 8 feet 10 inches. Each carried 535 passengers. Parliament was thus placed in a difficult position, because even if the Bill were thrown out, the boats were advertised to run on August 1, 1848, and as they belonged to a private firm the Legislature and the opposition companies were powerless to interfere. A month later, at the half-yearly meeting of the Chester and Holyhead Railway Company, the directors reported that their Bill had been successfully passed, and that the boats had commenced running on the advertised date. These boats were able to attain a speed of from 14 to 15 knots per hour. The opposition of the steam-ship companies, although not entirely killed, was less effective than formerly. The battle was won by the railway companies, and steam-ship owning by railway companies is now regarded as a matter of course.

Along the south-east and south coasts, between Harwich and Falmouth, the greater part of the Anglo-Continental passenger traffic, with a large amount of goods traffic, is carried by railway-owned steamers. To meet the heavy requirements of the cross-channel service between Dover and Calais, the South-Eastern and Chatham Railway Company run steamboats. These are the large paddle-steamers *Empress*, *Dover*, *Calais*, *Lord Warden*, *Le Nord* and the *Pas-de-Calais*, and the three turbine steamers *Queen*, *Victoria*, and *Empress*. The *Victoria* was built by Messrs. W. Denny Bros., Dumbarton, and is one of the finest boats owned by the company. On her trials she attained a speed of over $22\frac{1}{2}$ knots, being $1\frac{3}{4}$ knots in excess of the guarantee and sufficient to make the Channel passage under the hour. The *Empress*, built by the same firm, is generally similar to the *Victoria*; she is 310 feet long, 40 feet in moulded breadth, and 24 feet 6 inches deep from the awning deck, which extends from stem to stern. The rudder is of the balanced type, of a form specially designed by the builders for their turbine vessels,

and is worked by a steam tiller, controlled on the flying bridge by a telemotor. For convenience in canting and backing out of English and French harbours the vessel is fitted with a large bow rudder worked by steam steering-gear controlled by a wheel on the flying bridge. The propelling machinery consists of three turbines, each driving a separate shaft and propeller. For their Folkestone–Boulogne service the company also have the steamers *Princess of Wales*, *Duchess of York*, *Grace*, and *Mabel*, each of which is exceedingly fast and powerful.

London, Brighton, and South Coast Rly. Co.

A considerable amount of difficulty was experienced by the London, Brighton, and South Coast Railway Company in their preliminary attempt to open up the Newhaven–Dieppe route in 1847. As Brighton was a very unprotected departure and arrival station, and they were unable to come to terms with the Shoreham Harbour authorities, the company decided on Newhaven as the base for their cross-channel operations. The Brighton, Newhaven, and Dieppe steamers carried both passengers and cargo. As, at that time, it was illegal for railway companies to own steamboats, the South-Eastern Railway Company entered a complaint, and the London, Brighton, and South Coast Railway Company were mulcted in a heavy fine for the cross-channel trading that had already been carried on. The service was in consequence completely stopped and the boats sold. For three years Anglo-Continental trade was left to private steamship owners, and then an arrangement was entered into with Messrs. Maples and Morris to run steamers ostensibly on their own account, but really on behalf of the company. Among the earlier steamers thus employed were the *Ayrshire Lassie*, *Culloden*, and *Rothesay Castle*, all built at Glasgow. The extra amount of business anticipated from the Great

Exhibition of 1851 necessitated fresh arrangements being made in connection with the service, and an agreement was entered into by which Mr. Maples was to run his steamers for seven years. In the meantime the company endeavoured, but unsuccessfully, to obtain powers to own steamers themselves. At the expiration of Maples' contract, it was extended for another four years. During the second period the powers for which the company had been asking were granted by Parliament, but Maples would not release them till his contract expired. When he did leave the service he took with him the *Paris, Rouen, Dieppe, Marco, Hope*—the latter an iron brig noted for having about seven feet of false keel—and another, and £38,000 in hard cash, which he subsequently lost. The three Scotch boats mentioned ran through the whole of the summer of 1851, at the end of which the *Aquila* was also chartered for the company. Two of Maples' privately-owned boats on the Newhaven–Dieppe service were the screw steamers *Collier* and *Ladybird.* The latter was about 160 feet long, of 150 horse-power and steamed 11 knots. She was fitted with inverted geared engines to work the screw shaft, the ratio being 2½ to 1. Subsequently she went to Australia, and in 1854 carried the first Sydney to Melbourne mail. One of the most remarkable of the earlier boats employed by the London, Brighton, and South Coast Railway Company was the *Wave Queen.* She was built in 1852 by Messrs. Robinson Russell and Co. for a Belgian gentleman, whom she did not suit, and was sent to Newhaven by Mr. Scott Russell until he could get the *Lyons* and *Orleans* ready for use. She was of iron with a length of 200 feet, but her breadth was little more than 13 feet. For her beam she was one of the longest boats ever constructed, and consequently attracted a considerable amount of attention. Her engines were of 80 horse-power. She had clipper bows with very fine lines even for so narrow a vessel, and

she had also an exceedingly long overhanging counter. A special feature of her construction was the total absence of sheer, and she enjoyed the reputation of being a swift and dry boat. According to contemporary records she was held to be the smallest vessel then afloat capable of attaining the speed required. Her engines were of the oscillating type and made fifty revolutions per minute, and steam at 25 lb. pressure was supplied by two tubular boilers. These were 15·7 feet long, 10·5 feet wide, and 6·5 feet high, having a total grate area of 100 square feet and 2342 square feet of heating surface. The aggregate weight of engines, boilers, and water was 55½ tons. Her paddle-wheels, which were unusually small for her length, were 12·4 feet in diameter, and each had sixteen feathering floats 6 feet by 2 feet 6 inches, her average speed being 15½ knots and her load displacement 225 tons with a gross register of 196 tons. On one of her trips she ran into the West Pier fourteen feet, but although she remained fixed during one tide she did not start even a rivet, and was got off on the next tide without having admitted a drop of water.

The London, Brighton, and South Coast Railway Company started their Littlehampton trade in 1866. In 1875 the company acquired from Messrs. Elder the celebrated *Paris*, commonly spoken of as the most handsome steamer that ever crossed the Channel. Larger and faster vessels being required about this time for the Dieppe and Honfleur routes, they purchased the *Honfleur* from Messrs. Gurley Bros. She was 376 gross tonnage, had engines of 45 n.h.p., with two cylinders of 18 inches and 34 inches diameter and a piston stroke of 18 inches. The twin-screw *Rennes*, built in 1866, was sent to the Thames to be overhauled, and her engines were compounded by Messrs. J. and W. Dudgeon, the result being a great increase in speed and a reduction of somewhere about 45 per cent. in coal consumption. Two new screw steamers,

the *Newhaven* and *Dieppe*, were built for the company by La Société des Forges et Chantiers at Havre, but owing to structural imperfections, a considerable amount of trouble was experienced before they could be made to meet the requirements of Lloyd's and the Board of Trade. At their best they were very slow. A great increase in traffic being expected from the Paris Exhibition of 1878, two paddle-steamers, the *Brighton* and *Victoria*, were ordered from Messrs. Jno. Elder and Co. of Govan. Their bridges were filled with the first steam-steering gear ever seen at Newhaven. A larger type of boat than had been used heretofore was adopted in 1882, when the *Normandy* and *Brittany* were purchased from the Fairfield Company of Glasgow, and in 1885 the *Lyons* and *Italy* were obtained from Govan for the cargo trade. The vessels now employed are the *Arundel*, *Brighton*, *Calvados*, *Dieppe*, *Paris*, *Sussex*, and *Trouville*.

London and South-Western Rly. Co., etc.

Farther westward on the south coast, an equally important line of communication between England and France is maintained by the steamboat service now carried on by the London and South-Western Railway Company from Southampton to Havre and Honfleur, St. Malo and the Channel Islands. The early boats employed in the cross-channel traffic were all of much the same type and size on whatever line they were engaged, and as the same limitations of ports applied to those run by the South-Western Railway Company as to the steamers of other companies, there was little to choose between them in regard to speed, seaworthiness, or accommodation.

During the early years of the past century the mail and passenger service between England and the Channel Islands was performed by cutters similar to those employed in the French mail service between Dover and Calais.

Later the mails were conveyed under the auspices of the Admiralty from Weymouth to Guernsey and Jersey by the ships of H.M. Navy, *Meteor*, *Dasher*, *Wildfire*, and *Cuckoo*. The *Dasher* was employed until very recent years in guarding the fisheries off Jersey.

The first records of the steam-packet services from Southampton are dated 1835, and mention a service between Southampton and Havre twice a week in each direction by the *Camilla*, of 186 tons; and between Southampton and the Channel Islands by the *Ariadne*, 218 tons, these vessels being the property of the South of England Steam Navigation Company, who appear to have been the pioneers of these services. Even at that time there was opposition on the Channel Islands Station by the *Lord Beresford* and on the Havre station by the *Apollo*, both vessels belonging to the British and Foreign Steam Navigation Company. About one hundred passengers were carried to the Channel Islands on each trip during the summer season of 1835.

One of the earliest steamers employed in the Channel Islands service was the *Lady de Saumarez* (January 1836) of 350 tons, belonging to the British and Foreign Steam Navigation Company, with two 40-horse-power engines and fitted with Seaward's improved vibrating paddles.

In May 1836 the *Monarch* was launched from the shipyard of Rubie and Blaker, Northam, and was the largest steam vessel which had been constructed on the Itchen. Her dimensions were 140 feet long, 23 feet beam, 360 tons, and she was built in four months. Her engines, of 120 horse-power, were supplied by Horseley and Co. of Tipton, near Birmingham, and the vessel was sent to London to receive them. The *Monarch* was placed on the Havre station by her owners, the South of England Steam Navigation Company. On June 2, 1836, the *Atalanta*, of 400 tons and 120 horse-power, was launched

from the yard of Mr. Thomas White, West Cowes. She began running on the Channel Islands station for the South of England Steam Navigation Company during the month of July. The *Atalanta* was lengthened by Mr. White some years later, her bows being cut off and up-ended in his yard for a workmen's shelter. She ended her days as a coal-hulk in Jersey.

In July 1836 the *Watersprite*, a vessel of 200 horse-power, was put on the Channel Islands station by the British and Foreign Steam Navigation Company, which two years later became the Commercial Steam Packet Company. This company owned also the *Grand Turk*, a vessel of 500 tons and 300 horse-power, and she was reputed to be the fastest and most handsomely furnished ship of her day. Her saloon was 50 feet in length by 30 feet wide. She ran both to Havre and the Channel Islands, and in 1841–1842 had opposed to her the steamer *Robert Burns*.

The *Grand Turk* was chartered in 1848 for two years to run between Alexandria, Beyrout, Tripoli, and other Mediterranean ports with passengers and mails. On her return she plied between Southampton and Morlaix for the South-Western Steam Packet Company.

The *Transit*, another of the old steamers of the South-Western Steam Packet Company, was running in 1836 under the ownership of the British and Foreign Steam Navigation Company, between Southampton and Spanish ports, carrying cattle and general cargo. She is recorded to have made the passage from Lisbon to Falmouth in three and a half days during the winter of 1836. When withdrawn from this trade she was run to the Channel Islands by the South-Western Steam Packet Company, and she, too, ended her days as a coal-hulk.

Between 1838 and 1845 the mail service between England and the Channel Islands appears to have been

performed by a steam-packet service from Weymouth, of which no reliable records can be discovered. The transfer of this mail service to the steamers of the South-Western Steam Packet Company from Southampton took place on April 1, 1845. But in October 1899, when the steamers of the London and South-Western Railway Company from Southampton and the Great Western Railway Company from Weymouth were joined in the Channel Islands service the mails were once more carried via Weymouth three days a week during the winter months.

The advertisement columns of the *Hampshire Advertiser* of 1845 refer to the "South-Western Steam Packet Company" as the owners of the cross-channel steamers, and they seemed to have remained so until 1860, when their steamers were taken over by the London and South-Western Railway Company.

The merchants of the Channel Islands started an opposition company, called the Weymouth and Channel Islands Steam Packet Company, with the steamers *Aguila*, *Cygnus*, and *Brighton*. This opposition continued until 1888, when the service was taken up by the Great Western Railway Company. After keeping up a keen opposition to the London and South-Western Railway Company for eleven years an amicable arrangement was entered into for a joint service, which still continues.

In consequence of the opposition of the Weymouth and Channel Islands Steam Packet Company a South-Western Railway Company's steamer, the *Wonder*, was sent to Weymouth. This ran until 1860, when the Weymouth service was given up by the London and South-Western Railway and all their energies were concentrated upon the Southampton route.

Although steamers ran from Southampton to Jersey and thence to St Malo from 1845, the regular connection between Jersey and France was by a French company's steamer called the *Comet*. This company was bought

out by the London and South-Western Railway Company in 1867. The latter company then commenced running their steamer *Dumfries* regularly from Jersey to Granville and St. Malo in connection with the Southampton and Channel Islands service.

In 1860 a direct service was opened between Southampton and St. Malo by the new iron screw steamer *St. Malo*, the first of this type built for the London and South-Western Railway.

The paddle-steamer *South-Western*, the first iron steamer employed in the Channel Islands service, had a speed of about 12 knots. She was 131 tons net and was sold in 1863. Her floats were taken off and after being rigged for the purpose she was sailed out to Japan.

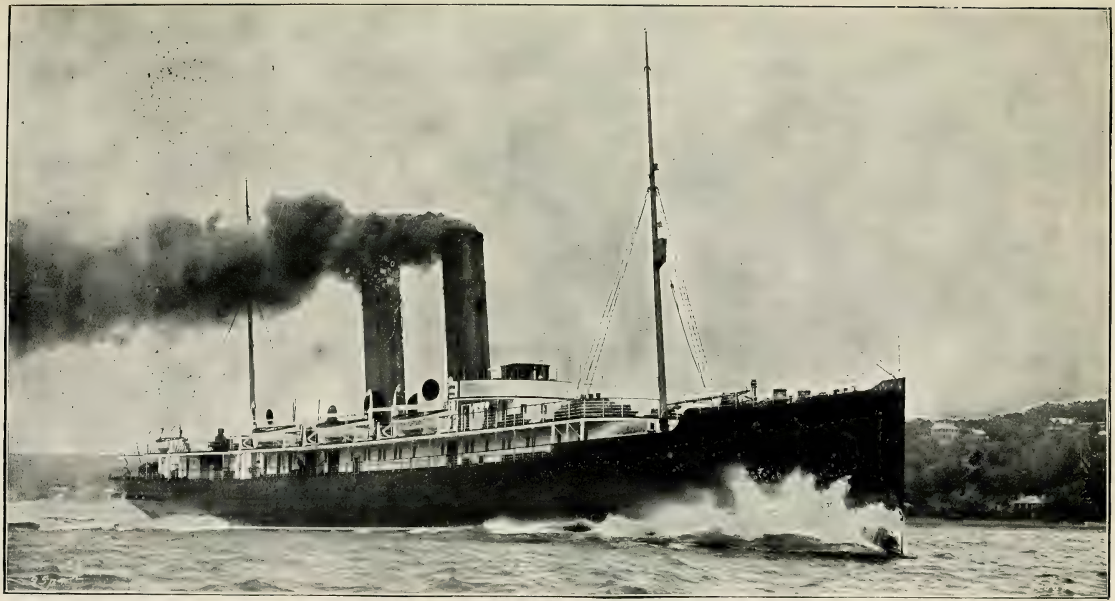
After the *South-Western* came the *Wonder*, *Express*, *Courier*, and *Dispatch*. They each had a speed of thirteen to fourteen knots. The *Express* was built and launched in six weeks. At the time she was laid down the engines put into her were in the yard ready for a Government steamer, but were used for the *Express* instead. This same *Express* was the steamer which brought Louis Philippe a fugitive from France in 1848, her commander on that occasion being Fred Paul, R.N., who had been lent by the Government to the company for that purpose. Louis Philippe, disguised as a fisherman, crossed from Honfleur to Havre in a fishing smack and was put on board the *Express* lying in the avant-port of Havre. As soon as his feet touched her deck, Commander Paul, who was lying under a full head of steam, slipped her moorings, steamed away and landed the fugitive at Littlehampton. A brass plate stating the facts was fastened to the sofa in the saloon, on which Louis Philippe slept. The *Express* was lost on September 20, 1859, on the passage from Jersey to Southampton in the Jailer Passage off the Corbière Lighthouse, Jersey.

The next steamers acquired by the company were the *Alliance* in 1855, *Havre*, *Normandy*, and *Southampton* in

1860, and *Brittany* in 1864. Until she was outclassed by larger and faster ships the *Alliance* was on the Havre route. She was afterwards transferred to the service between Jersey and St. Malo, and was sold in 1900.

The *Havre* ran alternately to her name-port and the Channel Islands until her career was ended on February 16, 1875, by the Platte Boue, a sunken rock in the Russel Passage near Guernsey. There was no loss of life and the mails were also saved.

Equal ill-fortune attended the *Normandy*. This boat, which was employed almost exclusively on the Channel Islands service, was sunk on March 17, 1870, in collision with the screw steamer *Mary* while on the outward passage, some twenty-five of the passengers and crew being drowned. The *Southampton*, built by Palmer in 1860, was reckoned the strongest vessel of her tonnage at that time. In 1880 she was lengthened and given new engines and boilers by Day, Summers and Co., and was engaged in the Channel Islands trade until 1880, when the service was entirely performed by screw steamers. She was then transferred to the Havre route and continued running there until the present twin-screw steamers, *Columbia* and *Alma*, came out and superseded her. Her last piece of active service was to make a trip round the fleet at Spithead on the occasion of the Jubilee Naval Review in 1897. The *Brittany*, built at Cubitt Town in 1864, was also employed in the Channel Islands trade until 1880, when, like the *Southampton*, she was transferred to the Havre route until 1894. Her last appearance was at the same review. She was lengthened thirty feet and given new engines and boilers in 1883. The company in 1868 purchased for their Channel Islands service the *Waverley*, a paddle-steamer of about fifteen knots, which had been employed running from Silloth to Dublin. She was the finest ship which had yet been employed on that service. She came to grief on June 5, 1873, when she struck



THE TURBINE STEAMER "ST. PATRICK" (G.W. RAILWAY).

p. 114

upon the Platte Boue rock. The whole of the passengers, mails, and baggage were brought off in safety.

The outbreak of hostilities between France and Germany in 1870 brought about the purchase by the company of the paddle-steamers *Alice* and *Fannie*. These each had a speed of fifteen knots, and were placed on the Southampton–St. Malo route and conveyed horses and provisions for the French. Both ships ran backwards and forwards for some months at their highest possible speed, only remaining at the quay side just long enough to load and discharge cargo.

The *Waverley* was also employed during that period running to and from Havre taking British provisions for the French, and conveying to England fugitive French families and all the valuables they could bring with them. These valuables were transhipped in Southampton Water to a steamer of the French Transatlantique Company, which was moored there for that purpose.

The *Fannie* and *Alice* ran alternately upon the Havre and Channel Islands stations until 1887, when they were sold out of commission. They were always favourites owing to their speed and spacious deck and cabin accommodation.

In 1871 the company purchased the paddle-steamer *Wolf*, which had been sunk for some time in Belfast Lough. She was employed, until sold in 1900, on the Havre route.

The first screw steamer to be employed in the Channel Islands mail and passenger service was the steam yacht *Griffin*, purchased in 1865 from a Mr. Beard, a Scotch iron-master.

The *Diana* was the first of the new screw boats built for the company and was launched in 1877, and in 1881 was supplemented by the *Ella* and in 1882 by the *Hilda*. Nine years later these vessels, together with the paddle-steamers *Brittany* and *Southampton*, were in their turn

superseded by the twin-screw steamers *Lydia* and *Stella.* The latter had a very successful career until March 30, 1899, when she foundered on the Casquets, her sailings being taken by the *Alberta.* A further change was made in 1894, the *Southampton, Brittany,* and *Wolf* being replaced by the *Columbia* and *Alma,* which were faster and more up-to-date boats. In 1896 the *Princess Ena,* a twin-screw vessel, was launched to replace the *Hilda,* and the *Vera* was also purchased as an auxiliary boat for the Channel Islands and Havre routes. Numerous additions have since been made by the company to their fleet, which now numbers twenty-six vessels. These are the *Ada, Alberta, Alexandra, Alma, Atalanta, Bertha, Cherbourg, Columbia, Duchess of Albany, Duchess of Connaught, Duchess of Edinburgh, Duchess of Fife, Duchess of Kent, Ella, Frederica, Guernsey, Honfleur, Laura, Lydia, Lymington, Princess Ena, Princess Margaret, Solent, South-Western, Vera,* and *Victoria.* These steamers all carry sufficient coal for the out and home trip, with an additional quantity to meet any contingency that may arise.

Great Western Rly. Co.

Another important south-coast mail and passenger service is carried on by the Great Western Railway Company from its southern terminus at Weymouth to the Channel Islands and Brittany. Formerly this company also conveyed mails and passengers between England and Ireland by their line of steamers from Milford to Rosslare. This has since been discontinued in favour of the Fishguard–Rosslare route.

Great Eastern Rly. Co.

Working arrangements exist between certain of the railway companies and the steam-ship lines, one of the most

THE R.M. TURBINE STEAMER "COPENHAGEN" (G.E. RAILWAY).

p. 116

important being the joint service maintained by the Great Eastern Railway Company and the General Steam Navigation Company from London to Hamburg, via Harwich. The steamers on this route sail twice weekly. There is also an agreement between the Great Eastern Railway Company and Danish Royal Mail steamers of the Forenade Line of Copenhagen by which these vessels convey passengers three times per week between Harwich and Esbjerg. The Great Eastern Railway Company also maintains a fleet of fast and powerful steamers for their Anglo-Continental mail and passenger business. This was started in 1863, when the company chartered two steamers for carrying goods between Harwich and Rotterdam. This service was made a biweekly one in 1864, and a similar service was also run to and from Antwerp. The company then introduced four new steamers specially built for the trade and conveying both passengers and cargo. In 1882, owing to the development of the traffic, the Harwich services to and from Rotterdam and Antwerp were extended to every week day.

The Hook of Holland quay at the mouth of the River Maas was finished in June 1893 and the company's steamers began to call there. This greatly accelerated the service to Berlin and other parts of North Germany and a daily service was then started. In the same year the company acquired larger steamers for this service. A new railway line round Rotterdam was opened in May 1899 which shortened the journey to Berlin; and in May 1903 an express train was run between the Hook of Holland and Berlin in connection with the steamers. Since the opening of this route the passenger traffic has trebled.

The company now have a fleet of eleven fast and powerful turbine and twin-screw steamers, all of which are fitted with apparatus for wireless telegraphy and submarine signalling. The latest addition is the Royal Mail

turbine steamer *Copenhagen*, with a speed of 20 knots, on the Harwich–Hook of Holland route. In her passenger accommodation she has many features of the latest type of Atlantic liner.

Great Central Rly. Co.

Farther along the east coast, the Great Central Railway Company maintains a service between Grimsby and several of the Continental ports. The company in 1864 secured parliamentary powers to run steamers to Hamburg, Rotterdam, Antwerp, Flushing, Lubeck, Stockholm, Copenhagen, Revel, Cronstadt, St. Petersburg, and Konisberg. Subsequently they purchased the Anglo-French Company's fleet and began to run steamers to Hamburg in July 1865. In April 1866, the railway company initiated a new service of steamers between Grimsby and Rotterdam, and in the August of the following year the service was extended to Antwerp. On December 1, 1885, the sailings between Grimsby and Hamburg were increased from two to four per week ; and on July 1, 1891, a daily service was established. The sailings between Grimsby and Rotterdam were increased in September 1906 from two to three per week, and early in 1907 two new 18-knot turbine steamers *Marylebone* and *Immingham* were placed on this service.

In essential particulars these are sister ships, though differing somewhat in their internal arrangements. The *Immingham* has a length over all of 282 feet, beam 41 feet, and depth moulded 21 feet 6 inches. Accommodation is provided for seventy first and twenty-four second-class passengers, and three hundred in the third class, besides one thousand tons of cargo. She is driven by three Parsons turbines actuating three shafts. These two steamers marked a new era in the Continental service from the Humber, being far in advance in accommodation and speed of anything hitherto employed.

RAILWAY COMPANIES' STEAM-SHIPS

London and North-Western Rly. Co.

On the west coast the principal part of the cross-channel, Irish mail, passenger, and cargo traffic is divided between the services organised by the London and North-Western Railway Company, the Midland Railway Company, and the Great Western Railway Company. For four years after the London and North-Western Railway Company had absorbed the Chester and Holyhead Railway, they continued to work the Irish service with the boats acquired from the latter company. A new type of paddle-boat, 230 feet in length, with carrying capacity of 700 tons, their speed being fourteen knots per hour, and conveying both passengers and cargo, was then put on for the service. The first of these, the *Stanley*, was built by Messrs. Caird of Greenock, and had as sister boat the *Alexandra*, constructed by Laird of Birkenhead. These vessels did excellent work and were afterwards supplemented by the *Countess of Erne*, *Admiral Moorsom*, *Duke of Sutherland*, *Duchess of Sutherland*, and *Edith*, all boats of a similar type. Two of these, the *Duchess of Sutherland* and the *Edith*, were in 1888 and 1892 respectively converted into twin-screw steamers. The *Duchess* was sold in 1908, but the *Edith* is still employed in the North Wall cargo service. This service was, in 1876, supplemented by a day express boat in each direction between Holyhead and Dublin North Wall, two paddle-steamers, *Rose* and *Shamrock*, being built by Messrs. Laird Bros. of Birkenhead. A night service in each direction was started in 1880 with the *Lily* and *Violet*, built by Messrs. Laird. They were each 310 feet long and had a gross tonnage of 1035 tons, with a speed of 19 knots per hour. The *Lily* was sold in 1900 and ran for some time between Liverpool and the Isle of Man. The *Violet* was also disposed of two years later. In 1884, the *Banshee*, another paddle-boat of the *Lily* type, was built for the company by Messrs.

Laird, and ran until February 1906, when she was sold out of the service. On December 15, 1897, the *Cambria*, the first of a new class of steel twin-screw steamers which almost equal the great ocean liners in speed, magnificence, and comfort, was placed on the North Wall service. She was followed by the *Hibernia* on February 2, the *Anglia* on May 2, 1900, and by the *Scotia* on April 23, 1902. The *Scotia* is 337 feet 6 inches in length, has a moulded breadth of 39 feet, with a depth to the awning deck of 29 feet 6 inches. The twin screws are driven by two sets of triple-expansion engines of 7000 horse-power, the eight single-ended boilers giving steam at a pressure of 160 lb. per square inch. There are four cylinders to each set of engines, which are balanced on the new Schlick principle, so as to avoid vibration. Even in the worst weather she can accomplish a speed of 21 knots. Her accommodation provides for 600 saloon and 700 third-class passengers.

A direct service between Holyhead and Greenore was opened in 1873 with the three paddle-driven boats *Eleanor*, *Isabella*, and *Earl Spencer*. These served until 1895, when, at the suggestion of Captain Binney, the company's Marine Superintendent, three new steamers of greater speed and capacity—the *Rosstrevor*, *Connemara*, and *Galtee-More*—were ordered for the service. These vessels are 280 feet in length, with a gross tonnage of 1000 tons, and a maximum speed of 18 knots. The engines are triple-expansion of 2500 horse-power, and the boats are propelled by twin screws. In 1908 the *Rosstrevor* was replaced by the *Rathmore*, the former vessel being converted into a cargo and cattle steamer. The *Rathmore* is 300 feet long, and has a gross tonnage of 1600 tons; her engines are of 6180 horse-power and give a speed of 20½ knots per hour.

The goods, cattle, and general cargo traffic between Holyhead and North Wall, Dublin, is served by eight

THE "SCOTIA" (L. & N.W. RAILWAY).

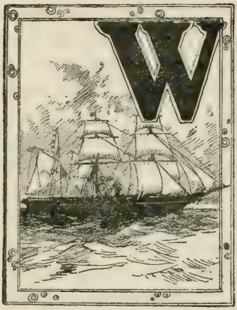
p. 120

cargo boats, all of which are twin-screw ships. They convey third-class passengers but are not provided with any first-class accommodation.

For very many years the Midland Railway Company were partners in the Barrow Steam Navigation Company, whose fleet maintained a daily service between Barrow and Belfast and, during the season, between Barrow and the Isle of Man. When Heysham Harbour was opened in September 1904, the Midland Company put on a fleet of seven powerful and magnificently fitted steamers of the most modern type for their Heysham–Belfast service. They also bought out the other partners in the Barrow Steam Navigation Company, which has now been dissolved. Two of the vessels formerly belonging to the Barrow Steam Navigation Company were disposed of at a comparatively recent date and have been broken up. As regards the existing fleet, the *Londonderry* is installed with the Lodge-Muirhead system of wireless telegraphy. The *Antrim* and the *Donegal* will shortly be similarly equipped. There is a wireless telegraphic station at Heysham and wireless communication was first established on the company's service nearly six years ago. The *Londonderry* and *Manxman* are propelled by turbines, whilst the *Antrim*, *Donegal*, *Duchess of Devonshire*, and *City of Belfast* are twin screws. During the season, the Isle of Man service between Heysham and Douglas is maintained by the *Manxman* and the *Duchess of Devonshire*. Except on Sundays, a nightly service between Heysham and Belfast is carried on regularly by the *Antrim*, *Donegal*, and *Londonderry*, whilst the *City of Belfast* runs on alternate days from Barrow and Belfast.

CHAPTER V

OPENING OF THE TRANSATLANTIC SERVICE



WHEN once the ability of steam-ships to make open-sea passages such as those between Liverpool, Belfast, and Glasgow had been demonstrated, shipowners began to turn their attention to the possibility of steamers crossing the Atlantic. The first steam vessel which is known to have made the crossing is the *Conde de Patmella.* Unfortunately very little is known about this boat. She sailed from Liverpool on October 20, 1820, for Lisbon, and arrived there in the remarkably short time of four days. Thence she sailed for the Brazils, being the first steam vessel to cross the Atlantic from east to west. In the year 1819 the *Savannah,* a sailing vessel using an auxiliary steam-engine, crossed the Atlantic, but as this vessel sailed nearly the whole of the way and scarcely used her engines except when leaving or entering port, she cannot be described as having made the first steam crossing, although this claim is often put forward by American writers. But this voyage of the *Savannah* is of great historical interest, as it proved what many had doubted, viz., the possibility of a sailing vessel with steam auxiliary crossing the Atlantic, and carrying enough coals for her purpose. This boat when built was not intended for a steamer. Messrs. Scarborough and Isaacs of Savannah

thought that a sail-plus-steam crossing could be made, and they accordingly instructed Moses Rogers (who, it has already been mentioned, had made the first sea trip by steamboat from New York to the Delaware in 1807 with Stevens' *Phœnix*) to look out for a hull in which an engine could be placed for the experiment. He found the *Savannah* then being built by Francis Ficket, of the firm of Ficket and Crocker, at New York, and she was accordingly purchased for Scarborough and Isaacs. Her engine is stated to have been built at Morristown, New Jersey, by Stephen Vail, though Daniel Dod * of Elizabeth, New Jersey—one of the foremost marine engineers of America at that time—who built the boilers and paddle-wheels, is sometimes said to have been responsible for the engines also. The paddle-wheels were constructed with eight radii, which were hinged at the axle, so that they could be folded and removed from the paddle-shaft, and stowed on deck in dirty weather. She was a full-rigged ship of 350 tons burden, 130 feet in length by 26 feet beam, and 16½ feet depth. Her trial trip in New York Bay in March 1819 was considered satisfactory, although the steam pressure employed was only 2 lb., while the estimated pressure was 10 lb. On March 28, 1819, she sailed for Savannah. Her engines were not used until April 2, when her wheels were placed on the paddle-shafts. They were shipped and unshipped at intervals, until the conclusion of the voyage on April 6. At Charleston, South Carolina, President Monroe, of "Doctrine" fame, visited her. She then returned to Savannah, and sailed thence for Liverpool on May 24 carrying neither passengers nor cargo.

On this first voyage to Savannah, which occupied 207 hours, the engines were running for only 4½ hours.

* Dod was killed in 1823 by the explosion of a boiler on a steamer whose engines he was testing after having made some experimental alterations.

On June 17 she arrived off the coast of Ireland, where the revenue cruiser *Kite* pursued her, under the impression that she was a ship on fire, and three days later she was off Liverpool. The voyage occupied 29 days 11 hours, and according to the record kept by Rogers, which is now preserved in the United States National Museum, steam was raised six times on the voyage and the engines were run for a total of 80 hours. The reason the engines were used so little was that she had a very insufficient supply of fuel. She steamed up the Mersey, her arrival—the arrival of the first vessel under steam from America—being witnessed by thousands of persons, some of whom could hardly believe their eyes, so often had the voyage been described as impossible of accomplishment.

Extracts from the *Savannah's* log read :

"*Saturday, May* 22, 1819.—These twenty-four hours begins with fresh breezes at N.E. at 7 A.M. got steam up, winded ship, and hove up the anchor, at 9 A.M. started with the steam from Savannah, at 12 A.M. anchored at Tybee stowed the boat and spars and lashed them. Latter part light breezes at S.E. and flying clouds.

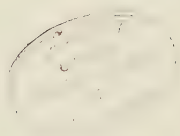
"*Sunday, May* 23, 1819.—These twenty-four hours begins with fresh breezes at east and clear, latter part light breezes and clear.

"*Monday, May* 24, 1819.—These twenty-four hours begins with light breezes and clear at 5 A.M. got under way off Tybee Light and put to sea with steam and sails, at 6 A.M. left the pilot, at 8 A.M. took off the wheels in twenty minutes, middle part pleasant. Course E.N.E., wind S.S.E., the ship going 6.7.8. to 9 knots, and without her wheels.

"*Tuesday, May* 25, 1819.—These twenty-four hours begins with light breezes and pleasant, all sail set to the best advantage at 12 A.M. Tybee Light bore W. 6 S. 8 leagues distant from which I take my departure."

THE "SAVANNAH."

p. 124



The ship continued under canvas until May 30, when at 8 A.M. steam was got up for ten hours. And on June 18 the captain entered: "4 P.M. Cork bore W. 6 S. 5 leagues distant. At 2 A.M. calm, no cole to git up steam."

A later entry on *Sunday, June* 20, 1819, reads: "5 P.M. shipped the wheels, frld. the sails, and running to the River Mercer at 6 P.M. came to anchor off Liverpool with the small bower anchor."

The voyage was not without its humorous side. The sailing master, Rogers, communicated to the New London (Connecticut) *Gazette* an account of their experiences. The Cape Clear telegraph station had reported a ship on fire, and the Admiral at Cork despatched a cutter to her relief.

"Great was their wonder at their inability," says the paper, "with all sail in a fast vessel, to come up with a ship under bare poles. After several shots were fired from the cutter the engine was stopped, and the surprise of her crew at the mistake they had made, as well as their curiosity to see the singular Yankee craft, can be easily imagined. They asked permission to go on board and were much gratified by the inspection of this naval novelty. On approaching Liverpool hundreds of people came off in boats to see her. She was compelled to lay outside the bar till the tide should serve for her to go in. During this time she had her colours all flying, when a boat from a British sloop of war came alongside and hailed. The sailing master was on deck at the time and answered. The officer of the boat asked him—'Where is your master?' to which he gave the laconic reply, 'I have no master, sir.' 'Where's your captain, then?' 'He's below; do you wish to see him?' 'I do, sir.' The captain, who was then below, on being called, asked what he wanted, to which he answered—'Why do you wear that pennant, sir?' 'Because my country allows me to, sir.' 'My commander thinks it was done to insult him, and if you don't take it down he will send a force that

will do it.' Captain Rogers then exclaimed to the engineer—'Get the hot-water engine ready.' There was no such machine on board, but the order had the required effect and the boat sheered off."

From Liverpool the *Savannah* sailed for St. Petersburg, calling at Elsinore and Stockholm. This voyage lasted thirty-three days, on ten of which the vessel was under steam; and twice the machinery was run for a spell of fifty-two hours. Eighteen hours was her longest spell while crossing the Atlantic. The homeward voyage was made in the stormy months of October and November. The paddles were unshipped throughout that voyage and were not again used until November 30, when she arrived at Savannah, the ocean journey having been made under sail only. The cost of purchasing and fitting out the *Savannah* for this experimental voyage was £10,000. In December she returned to New York, her machinery was removed, and she was then used as a sailer between New York and Savannah until 1822, when she left her bones on the shores of Long Island.

One of the earliest steamers to cross the Atlantic in a west-bound direction was a little vessel called the ***Rising Star***.* It was decided in 1818 that she should be built, but it was not until 1820 that her construction was begun. It has even been disputed that this vessel made the voyage at all, and many of the principal books of reference do not mention her; nevertheless, it appears to be indisputable that she existed, that she made the voyage to Chili, and that she had an eventful career which lasted several years, and was finally wrecked; and that the circumstances under which she left this country for Chili in connection with the Chilian revolution in favour of independence, and the events subsequent to her arrival as

* The "Dictionary of Dates" and the American "Universal Gazetteer" give the name of the vessel as the *Rising Sun*, but this would appear, from Lord Dundonald's papers, to be incorrect.

far as paying for the steamer is concerned, reflect as little credit upon the Chilian Government as upon that of Great Britain. Early in the last century the relations between Chili and Spain became strained to breaking-point. The Chilian people determined to free themselves from the yoke of Spain and to establish a republic. Whatever may be the case now, there is little question that one of the characteristics of all the South American States at that time and for many years afterwards was an extraordinary ingratitude towards those who had in any way helped them. The history of that revolution and of the prominent part which Lord Cochrane played in bringing it to a successful issue are too well known to need recapitulation, but a short reference to it is not out of place in considering the circumstances under which the *Rising Star* was sent on her journey.

In a recent letter to the writer Lord Dundonald says: "In 1817, when my grandfather, the tenth Earl of Dundonald, was engaged by the Chilian Government to create and take command of the Chilian Navy, he made a stipulation that a steamboat should at once be constructed and sent out to Chili to take part in the war, his opinion being that the great disparity in numbers between the Chilian Navy and the Spanish Navy in the Pacific would be neutralised by the advantage obtained in utilising a steam vessel for purposes of war. The vessel was constructed on the Thames at Rotherhithe, and my grandfather had anticipated going out in her, but as she took longer in construction than was expected, he went out with his wife and two children in the *Rose* merchantman of 300 tons.

"It appears that the *Rising Star* was taken out by my great-uncle, Major the Hon. William Cochrane, but apparently she arrived in Chili when my grandfather had practically swept the seas of the Spanish fleet; a revolution had just taken place on her arrival and there was no money available to pay for the *Rising Star*. The history

of the claim made against the Chilian Government by Major the Hon. William Cochrane of course need not be gone into except in a word or two; as you will understand, Chili was at that time a prey to revolution and a poor country with little money and little credit; she repudiated obligations at that time and would be much ashamed of her action now."

Don José Alvarez, the Chilian agent, in a communication to Lord Cochrane, had called attention to the "unfortunate delay," and urged him to embark immediately with his family in the ship *Rose* to proceed to Chili. The agent's letter contained "the assurance that I will attend to the affairs of the *Rising Star*, and take care that everything is done to her."

The memorial of the Hon. William Erskine Cochrane to the President of the Chilian Republic many years later, in reciting the circumstance, states that Mr. Edward Ellice, then an eminent English merchant and a well-wisher to the independence of Chili, undertook the completion and equipment of the *Rising Star*, but after having expended £8000 and the machinery being found defective, he declined making any further advance, and being unable to obtain repayment of the sum he had expended or the funds requisite for the necessary alterations and equipment he advertised the vessel for sale. Don Alvarez then wrote to Lord Cochrane on April 18, 1820, announcing Messrs. Ellice and Co.'s intentions and solicited his assistance and added: "I shall, on the part of the Government of Chili, agree to the following terms: The ship, engines and stores to be sold or made over to any one of your nomination for £6000; by that person and at his expense, the engines must be altered in the following manner, viz., the pipes which convey the steam from the boilers to be removed and larger ones provided. Alterations to be made in the condensers. The paddle-blades to be altered. The smoke apparatus to be completed and fitted, and the

effect of the engines tried. The ship must then undergo any necessary repairs in her hull and rigging, when she must be manned, victualled, insured, and conveyed to Chili at the expence of the purchaser; boats and pumps of which she is now deficient must also be provided. The amount of these various items, together with the interest of money and profit, to be calculated at nine thousand pounds, so that on the arrival of the vessel at Chili she will be purchased by Government at fifteen thousand pounds.* In addition to which the licences formerly granted to Messrs. Ellice for the importation of goods to the amount of 40,000 dollars† of duties shall be made over and transferred to the person who undertakes this matter, and all property conveyed out in the *Rising Star* shall be admitted into Chili free of duties." ‡

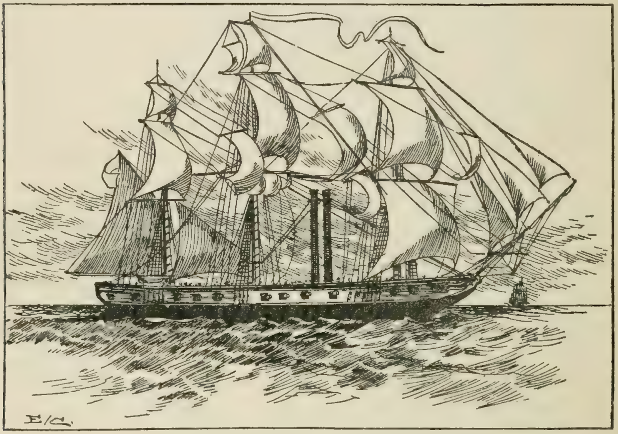
The *Rising Star* was completed, and arrived at Valparaiso in April 1822. But Lord Cochrane's work was practically over and she was therefore not required for the purpose originally intended of enabling the Chilians to cope with the Spanish Navy. In June 1823 there was a sudden change of government in Chili, and the O'Higgins Cabinet was overthrown. The change was accompanied by the restless outbreaks which have often marked political differences in the South American States, and a good many of the papers relating to the building of the *Rising Star* and sending her to Chili were destroyed.

The new Chilian Government, being very short of money, took advantage of the destruction of the papers and repudiated the obligation to Lord Cochrane. It would take too much space to go into the details of this lamentable affair, but it is sufficient to say that the vessel was sold, that the Cochrane interest in her vanished, and the Hon. Wm. E. Cochrane was called on for payment of

* This includes the £6000 paid for the ship.
† These were originally granted as a bonus.
‡ No goods were taken out in the ship.

a considerable additional sum solely in consequence of the vexatious delay of the Chilian Government in saying whether they would or would not fulfil their engagement.

From a journal kept by Major W. E. Cochrane it appears that on May 31, 1820, he made his first payment of £50 on account of the vessel to Mr. Kier, engineer. He seems to have visited very frequently the



THE "RISING STAR."

yard at Deptford where the vessel was built, sometimes with the Chilian agent, and payments on account of construction of £50 or so are frequent. By the 14th of the following September the engines were sufficiently advanced to undergo a trial, with what result is not stated. On October 6, he paid Mr. Ellice £2000 on account of the price of the ship. On the 17th he paid her another visit, when the engines were tried, and on the 18th he went again and tried the open paddles. Extensive alterations to the engines were

necessary, for on November 11 there appears the item that he paid the balance of Kier's account for that work, £163 4*s.* 11*d.* On January 30, 1821, he went and took dimensions for the smoke-burning apparatus.

The *Rising Star* left the dock on February 5, when the engineers received £1 for working on Sunday. On the 7th, the wheels were tried and one of them broke, and on the 8th he ordered the wheels to be brought to town. On the 16th, a payment was made of £79 19*s.* "for the deeds relating to the purchasing of the *Rising Star.*" On the 21st, he paid a bricklayer for constructing the smoke-burning apparatus in the flues of the boilers. Presumably the repairs were effected after the ship had been returned to dock, for on February 22 she was taken out of dock again. On March 20, the name of Captain Scott, as master, first appears. On the 24th, Major Cochrane "went to the ship and got the balance wheels fixed," and on the 26th "tried the wheels, which did not propel." The weights were taken off the paddles on the following day and reversed, and another trial was made of which the result is not stated, and there was yet another trial on the 11th of the following month. In April he paid to Mr. Brent, the builder, for docking the *Rising Star*, £120 15*s.* 3*d.* On May 9 he ordered "my new vertical paddles," which were erected on the 29th. On this date there is a curious entry: "Steward and boat 6*s.* 6*d.*," which is probably the first recorded instance of a ship's steward receiving a tip. The wheels were tried while the vessel was in dock on June 8, and were found to act well, and Don José Alvarez visited her the next day.

On the 11th of that month the first real trial of the ship took place, for the entry reads: "Tried the ship with my vertical paddles. She went from 5 to 6 knots, (standard broke)." A new standard was ordered and on July 5, "tried my new paddles, went 20 miles at the

rate of $5\frac{3}{4}$ knots an hour." On the 18th of that month he paid Brent's bill for alterations and repairs, £193 3*s.* 8*d.* On September 4 the ship was taken five miles down the river, and on the 11th he "ordered her into dock to have her paddle-case closed (on account of insurance)." The paddle-cases were fitted on the 13th, and on October 17 she went down to Gravesend. Then comes a series of entries which are interesting as showing the rates of pay at the time.

They are as follows, and are dated October 18:

Paid one month's wages to Captain Scott	£10	0	0
Paid William Ford, Carpenter, for the voyage	13	10	0
Mr. Cook, Mate, one month's voyage *	4	0	0
To Cluly, 2nd Mate, one month's wages	3	0	0
To Leach, Steward	6	0	0
Wages of Seamen	20	6	6

The *Rising Star* sailed from Gravesend on October 22, 1821. Numerous heavy bills came in shortly afterwards, among which are "Insurance on ship £800," and Mr. Brown's account, in which is included the heavy expenses at Cork, when the ship put in there in distress, having sprung a leak off the coast of Portugal, £913 9*s.* $1\frac{1}{2}$*d.*

Altogether the actual outlay in cash amounted to £13,295 4*s.* $4\frac{1}{2}$*d.* The sum agreed upon in the arrangement with Don Alvarez was £15,000, to which was added the interest to the year in which the claim was made thirty-four years later, bringing the total amount of the claim of the Cochrane family on account of this little steamer to £40,500.

Mr. W. Jackson went to Chili to join Lord Cochrane as secretary, and remained with him in that capacity until his lordship's return to England. Mr. Jackson wrote on June 20, 1856, from Melton Mowbray: "I sailed in her [the *Rising Star*] to Valparaiso, having been appointed joint agent with Mr. Barnard, already at that place, for her

* Wages is probably meant.

transfer to the Chilian Government. She arrived there in April 1822 in excellent condition, having proved herself a very superior sea-boat, frequently going twelve knots an hour. She was then tendered to the Government on the terms of the contract, but they first claimed her in virtue of a partial advance they had made for the building of the hull, and failing to obtain possession on that ground they repudiated the contract with Alvarez altogether, without assigning any valid reason for so doing. The sum agreed to be paid on her delivery was £15,000, no part of which was there received."

Unfortunately, little is known as to the nature of her machinery or means of propulsion. An illustration of the *Rising Star*, published in 1821, represents her as a full-rigged ship and carrying two funnels placed abreast and situated between the main and fore masts; but she seems to have neither paddle-boxes nor uncovered paddle-wheels. The description attached to the picture states that the *Rising Star* was "built under the direction of Lord Cochrane upon the principle of navigating either by sails or by steam, the propelling apparatus being placed in the hold and caused to operate through apertures in the bottom of the vessel."

From this it may be conjectured either that the paddles were discarded or that she was also fitted with some modification of the jet system.

Although no further attempt was made to send a steamer across the Atlantic for many years, the project was not lost sight of, and schemes innumerable were formed and abandoned. Ten years after the *Savannah's* voyage some Dutch merchants purchased the *Curaçoa*, a Clyde-built vessel of 320 tons, and despatched her to the West Indies from Antwerp. Her engines were of 100 horse-power, and consumed slightly over seven pounds of coal per indicated horse-power per hour, but there is no record of her having attempted to make the voyage under steam.

The first steamer to cross the Atlantic from west to east depending largely though not entirely on her own steam was the *Royal William*, built by James Goudie for the Quebec and Halifax Steam Navigation Company at Quebec, in the shipyard of Black and Saxton Campbell, upon the lines of an early Clyde steamer, the *United Kingdom*, built by Steele of Greenock in 1826 for the London and Leith service. She was 176 feet long, and 146 feet between perpendiculars. Her beam was 27 feet, and outside the paddle-boxes 43 feet 10 inches, and her depth 17 feet 9 inches. Her tonnage is variously given as 830 gross * and 1370 B.M.† She had side-lever engines of 180 horse-power ‡ or 200 horse-power, § by Boulton and Watt. She was engined at St. Mary's foundry, Montreal. Her launch took place on April 29, 1831, and after trading for a time between Quebec and Nova Scotian ports she was sold to another company, which ultimately tried the experiment of sending her across the Atlantic. Mr. Samuel Cunard was one of the directors of this company, but there is nothing to show that he assisted in the promotion of the scheme to send her over the ocean.‖ Nevertheless it is a fact that "the idea of starting a line of steamers to connect the two countries had occurred to his mind as early as 1830."¶ On August 4, 1833, the *Royal William* sailed from Quebec, coaled at Pictou, and began her journey. She is said to have steamed the greater part of the way, some writers say the whole of it, and arrived at Gravesend on September 11 after calling at Cowes. Probably owing to there being another vessel of the same name a few years later, some misconception has arisen as to her performance, for as a matter of fact, the first *Royal William* did not

* "The Atlantic Ferry."
† Kennedy's "History of Steam Navigation."
‡ *Ibid.* § "The Atlantic Ferry." ‖ *Ibid.*
¶ "History of the Cunard Company."

The "Dieppe" (L.B. & S.C.R.).

The "United Kingdom."

p. 134

steam all the way, but made a considerable portion of the voyage under sail alone. It is to the credit of Canadians, however, that this steamer was despatched, and it is upon this particular enterprise that the claim of the Canadians to have made the first steam-ship voyage across the Atlantic is founded. The subsequent history of this vessel is interesting. She stayed in the Port of London for a few weeks, after which she was chartered by the Portuguese, and while in their service her speed attracted the attention of the Spanish Government. The Spaniards purchased her towards the end of 1833 at the time of the first Carlist rebellion and changed her name to the *Ysabel Secunda.* It was shortly after this that she obtained the doubtful honour of being the first steamer to fire a gun in war, the Spaniards having armed her with six cannon. Her eventful career ended when she went to pieces on the Santander rocks.

These two voyages stand in a class by themselves, and both mark a distinct step forward in the progress of the modern mercantile marine. The earliest steamboats, whether European, British, or American, were smooth-water vessels only, and were admitted to be of an elementary and experimental character. The *Charlotte Dundas* and *Comet* in Scotland and the *Clermont* and *Phœnix* in America were much beyond anything that had preceded them, and were significant as indicating a perception of the possibility of extending the activity of steam-propelled boats from the placid waters of canals or rivers to the greater waters of harbours, ports, and estuaries. The four vessels first named demonstrated, each in her own way, that it was necessary to build the hull to suit the engine, instead of acquiring a hull and putting an engine into it and trusting to luck. The *Phœnix* showed in 1807 that a vessel constructed to carry a steam-engine of a suitable size could be trusted on the open sea, by steaming from New York to the Delaware.

A few years later, the Clyde shipbuilders showed that they could construct steamers which should go down the Clyde estuary and even essay the journey to Ireland.

It is true they used sails whenever possible, but when winds or tides were against them the engines alone were depended on. Vessels with two and three masts were employed, and as marine engines were made of greater size, power, and weight, vessels of greater dimensions were equipped with them, and the coastal service was inaugurated. By this time the engine had become a powerful auxiliary to sail on short voyages for which large bunker space was not required. The maintenance of the coastal voyages in all weathers proved the thorough seagoing qualities of the steamers. In estimating the value of the *Savannah's* voyage and its place in the history of steam navigation, it must not be forgotten that she was a sailing vessel, was built to be one, that the form of her hull was not altered in any way when she was engined, and that on her return, when her machinery was taken out of her, she resumed her place in her country's trade as a sailer. Quebec's *Royal William*, on the contrary, was designed and built to be a steam auxiliary vessel, and it was not until she had established herself in that capacity that her voyage to the Mother Country was decided upon. The performances of these two ships were thus of great importance; they demonstrated, in the case of the *Savannah*, that a little sailing ship could carry a small auxiliary engine which might help her in and out of port, and at other times if it were necessary and fuel permitted; and in the case of the *Royal William* that a steam packet could essay an ocean voyage and depend both upon her sails and steam-engines to enable her to reach her destination in good time.

No further attempts were made, however, until 1838, which was destined to become a memorable year.

Before this, various companies had been proposing to

build steamers, but nothing had been done. In 1828 an Act of Parliament was obtained for the incorporation of the Valentia Transatlantic Steam Navigation Company, which was to run a line of steamers from the west coast of Ireland to America. The company proposed to build a steamer at a cost of £21,000. She was to carry fifty cabin passengers and as many in the steerage, and 200 tons of cargo in her hold. It was suggested that she should be of about 800 tons displacement, with engines of 200 horse-power, and her speed was to be such that she could make six voyages each way in twelve months. The company announced in 1828 that it would commence operations immediately, but the public held aloof, and seven years later matters were no further advanced.

Then the project was revived, and considerable interest was taken in it because it was suggested that the enterprise should be worked in connection with the new railway from London, the new Post Office packets and the Valentia Railway.

It was at this time that Dr. Lardner, a man of recognised scientific attainments, made his remarkable assertion regarding the impossibility of establishing steam navigation between New York and Liverpool. According to a report of a meeting at which Dr. Lardner was present, that gentleman pointed out that "the only difficulty would be as to the run from Valentia to St. John's." He continued: "As a last resource, however, should the distance between Valentia and St. John's prove too great they might make the Azores a stage between, so there remained no doubt of the practicability of establishing a steam intercourse with the United States. As to the project of making a voyage directly from New York to Liverpool, it was, he had no hesitation in saying, perfectly chimerical, and they might as well talk of making a voyage from New York or Liverpool to the moon." *

* Liverpool *Albion*, December 14, 1835.

While England was listening to the depressing remarks of Dr. Lardner, America was at work.

In 1835 Junius Smith* from Massachusetts began to consider the navigation of the ocean by steamers, and in 1836 he proposed to form the British and American Steam Navigation Company. The company was actually established in 1837 by Mr. Macgregor Laird with a capital of £1,000,000, but Smith's connection with the scheme ceased, as he saw himself unlikely to make as much out of the enterprise as he had anticipated.

Mr. Kennedy's "History of Steam Navigation," however, states that Doctor Julius Smith organised in 1836 "a transatlantic steam-ship company bearing the title of the 'British Queen Steam Navigation Company,' with a capital of £1,000,000, and Mr. Macgregor Laird as secretary." The most remarkable event in the annals of this company is the voyage of the *Sirius* from London to New York in 1838. "The *Sirius!* The *Sirius!* The *Sirius!* Nothing is talked of in New York but about the *Sirius.* She is the first steam vessel that has arrived here from England, and a glorious boat she is. . . . Lieutenant Roberts, R.N., Commander, is the first man that has navigated a steam-ship from Europe to America." † The *Sirius* was sent across the Atlantic really as a desperate remedy against competition.

The Transatlantic Company had placed a contract as early as 1836 with Messrs. Curling and Young of Blackwall, London, for the construction of the *British Queen* steam-ship, but the bankruptcy of Messrs. Claude Girdwood and Co. of Glasgow, who had contracted to build the engines, caused considerable delay. Enterprising rivals at Bristol, seizing the opportunity, formed the Great Western Steamship Company to build and equip the

* The name is given as "Junius Smith" in Appleton's "Cyclopædia of National Biography."

† New York *Weekly Herald.*

Great Western, which they determined to put on the service before the *British Queen* could be got ready. In this they were successful, and to save the honour of their own company the *British Queen* directors hired the *Sirius* from the Cork Steamship Company. It was known at the time that she was too small to be employed as a regular transoceanic trader, and even before she started on her first voyage the announcement was made that she would make two voyages only.

She was 178 feet long, $25\frac{1}{2}$ feet broad, $18\frac{1}{4}$ feet deep, and of 703 tons register. Her engines, like those of all other vessels of her time, were of the side-lever type; their cylinders were of 60 inches diameter, and had a stroke of 6 feet, and she carried a surface condenser similar to those now in use. She was a two-masted vessel, carrying three square sails on the foremast, her aftermast being fore-and-aft rigged only. She had one funnel situated abaft the paddle-boxes, which were about amidships. A picture of the vessel is in existence which represents her as three-masted, and with her paddles rather far forward, but this is inaccurate. She was almost a new ship at this time, and it is not likely that a mast would have been taken out of her between her launch and her Atlantic voyage. Her schooner bows bore as figurehead a dog with a star between his front paws.

The *Sirius* left London, sailing from East Lane Stairs, on March 28. She took no goods, as she was intended to be a passenger steamer only. On going down the river she overtook the *Great Western* "with a respectable pleasure party on board," and a trial of speed was the consequence. When the *Sirius* had reached Gravesend she was upwards of a mile ahead of her rival. She had made the distance from Greenwich to Gravesend against a strong tide in one hour and fifty-six minutes. Both ships had their colours hoisted, and the banks of the river were thronged with spectators. Soon after the departure

of the *Sirius* the American Line packet-ship *Quebec* came down the river in tow, and wagers were freely laid that the *Quebec* would arrive before the *Sirius* at New York. But those who backed the *Quebec* lost their money.

The *Ocean*, a vessel belonging to the Irish Company, acted as tender to the *Sirius* when the latter called at Cork, and arrived there from Liverpool on April 3, with mails and passengers for the venturesome little craft. At a few minutes after ten o'clock on the morning of the 4th, the *Sirius* proceeded on her voyage. The day was beautifully fine, every vessel in the harbour was decked with flags in honour of the event, a salute was fired from the battery on shore, and every boat which could be pressed into service was crowded with enthusiastic sightseers when, accompanied by the *Ocean*, the vessel left the harbour. The *Ocean* went with her as far as the entrance to the bay.

The *Watt*, which arrived at Liverpool on April 8, reported having sighted on April 5, in latitude 51° N. and longitude 12° W., the *Sirius* bound for New York, bravely encountering a westerly gale. "When it is considered," the Liverpool *Standard* of the day naively remarked, "that this is the first steam vessel to cross the Atlantic, this information may not be altogether unimportant."

New York was reached at ten o'clock in the evening of April 22, not without some adventure. Lieutenant Roberts, her commander, was determined to carry the voyage through, but it was only "thanks to stern discipline and the persuasive arguments of loaded fire-arms" that he brought the crew round to his way of thinking, as they became somewhat demoralised by continuous head-winds and declared that it was utter madness to proceed in so small a vessel. There were 94 passengers on board, of whom 30 were in the state-

THE "SIRIUS," FROM A PRINT OF 1837.

p. 140

cabin, 29 in the fore-cabin, and 35 were steerage passengers.*

The passage occupied sixteen and a half days, and the average speed was $8\frac{1}{2}$ knots per hour; about twenty-four tons of coal per day being consumed. Her arrival at New York was hailed with delirious enthusiasm, and the excitement was yet further intensified when it became known on the morning of the 23rd, only a few hours after the *Sirius* had anchored off the Battery, that another steam-ship was sighted making its way to the port, and that the approaching vessel was greater than any steam-ship ever seen in American waters.

This was the *Great Western*, and New York celebrated the double arrival with that strenuous abandon attainable only in the Empire City.

The *Great Western* was built at Bristol by Patterson. She was brought round to London and left London again for the western port on March 31. Off Southend she was discovered to be on fire, and the heat and smoke were so great that all the engine-room staff had to take refuge on deck. Fortunately they had forgotten to stop her engines, and the vessel was beached on the Chapman Sands, her decks were cut into, and volumes of water were poured upon the flames. The fire was soon extinguished, and the damage was found to be much less than was feared. She floated on the tide and resumed her voyage under her own steam to Bristol. The fire was due to the ignition of the felt packing round the

* It has been said the *Sirius* carried no passengers. According to *Notes and Queries*, the New York *Herald*, of April 28, 1838, in reporting the arrival of the *Sirius*, says that forty-two passengers were on board, of whom eleven were females, for whose accommodation a stewardess was carried. A contributor to *Notes and Queries* quotes the authority of the Registrar-General of Shipping and Seamen for the statement that the stewards' department consisted of three stewards, one assistant, two cooks, and a boy, and he asks whether this staff would have been required in an ordinary boat of 412 tons if there were no passengers.

boilers. Owing to this adventure the *Great Western* did not sail from Bristol for New York quite as early as was expected, and it was this delay which enabled the *Sirius* to gain pride of place. The *Great Western* left for New York three days after the departure of the *Sirius* from Cork. Her average speed to New York was 208 knots per day, and she used 655 tons of coal on the voyage. Another account, published in 1840, says that of her 660 tons of coal only 452 were used when she reached New York. On her homeward voyage her speed was nearly 9 knots an hour as against the 8·2 knots outward, but she burnt only 392 tons of coal, the difference being accounted for by the fact that on the outward voyage she experienced very rough weather. Although she made a much faster passage than her little rival, it is but fair to remember that she was nearly twice her size, and with engines developing more than twice the horse-power.

A contemporary writer thus describes the *Great Western:* "The officers, crew, and engineers are about sixty in number. The saloon is 75 feet long, 21 feet broad, exclusive of recesses on each side, where the breadth is 34 feet and the height 9 feet. The decorations are in the highest degree tasteful and elegant, and the apartment may vie with those of the club-houses of London in luxury and magnificence. The splendour of a saloon is, however, a matter of very inferior consequence, and it is higher praise to state that the more essential parts of the vessel and all her machinery are examples of mechanical skill and ingenuity which cannot be surpassed."

The saloon was decorated with about fifty panels, the larger ones, according to a contemporary description, representing "rural scenery, agriculture, music, the arts and sciences, interior views and landscapes, and parties grouped, or engaged in elegant sports and amusements; the smaller panels contained beautifully pencilled paintings

THE "GREAT WESTERN." FROM A PRINT OF 1837.

p. 112

of Cupid, Psyche, and other aerial figures." * Every berth and cabin had a bell communicating with the stewards' room, the method of communication being described as follows for the instruction of travellers: "When the attendance of the steward is required, the passenger pulls the bell-rope in his berth, which rings the bell in the small box (in the stewards' room) and at the same time by means of a small lever forces up through a slit in the lid a small tin label with the number of the room painted requiring the services of the steward, and there remains, until the steward has ascertained the number of the room and pushed it down again. Thus, instead of an interminable number of bells there are only two. This arrangement, which is alike ingenious as it is useful, is deserving the notice of architects." †

From the same publication it appears that the floors are of great length and overrun each other. "They are firmly dowelled and bolted, first in pairs and then together by means of 1½-inch bolts about 24 feet in length, driven in four parallel rows. The scantling is equal in size to that of our line-of-battle ships; it is filled in solid and was caulked within and without up to the first futtock heads previously to planking, and all to above this height of English oak. She is most closely and firmly trussed with iron and wooden diagonals and shelf-pieces, which with the whole of her upper works are fastened with screws and nuts to a much greater extent than has hitherto been put in practice. Her engines are the largest marine engines yet made. The boilers are constructed with several adaptations for the economy of steam and fuel on an entirely new principle. There are four distinct and independent boilers, any number of which can be worked as circumstances require. The wheels have the cycloidal paddles. The figure-head is a demi-figure of Neptune

* *The Mirror.*

† *Civil Engineer and Architect's Journal.*

with gilded trident, and on each side are dolphins in imitation bronze."

The *Sirius* made two transatlantic voyages as advertised, and was utilised henceforward for the trade for which she was built, namely, carrying passengers and goods between ports on the coast. She traded chiefly between Liverpool, Cork, Glasgow, and London, and occasionally to St. Petersburg, and at last, in June 1847, she was wrecked in Ballycotten Bay.

While the *Sirius* and *Great Western* had been monopolising the attention of the public, the directors of the City of Dublin Steam Packet Company, who had already formed a company to join in the transatlantic traffic, determined upon making their start with the new paddle-steamer *Royal William*. This was not the Canadian *Royal William*, but a boat built in 1836 by Wilson of Liverpool, with engines by Fawcett and Preston, and one of a quartet intended to compete with the Government steamers carrying the mails between Liverpool and Kingstown. She was a faster vessel than any of the Government boats. One voyage, in which she created a record which stood for some time, was when she was engaged between London and Dublin, and did the 260 miles run from Falmouth to Kingstown in 23 hours. She was slightly shorter than the *Sirius*, but her capacity was 817 tons gross, and her engines of 276 horse-power. Although she had accommodation for eighty passengers, she had on board only thirty-two when she started from Liverpool on Thursday, July 5, 1838. She carried no cargo, all the space apparently being used for fuel.

"Coal filled her bunkers, her holds, and even her well-deck, so that her paddles were buried six feet, her sponsons were submerged, and it was possible, by leaning over the bulwarks, to wash one's hands in the water that surged at the vessel's sides."* Her departure

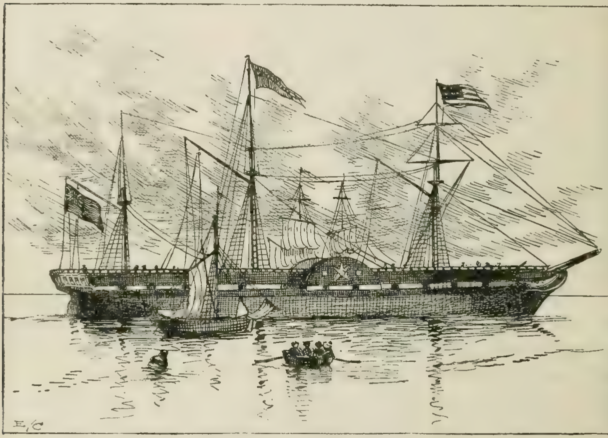
* Kennedy's "History of Steam Navigation."

from Liverpool was celebrated in a manner befitting the occasion; the spectators gathered by thousands, and every cannon on either side of the river that could be used to fire a salute was requisitioned, while the steamers and large sailing ships anchored in the river, many of which carried guns, joined in the salute. The outward voyage lasted nineteen days, but she did the passage back in fourteen and a half days.

While she was being got ready, the directors accepted an offer from Sir John Tobin to run a steamer, which was built for him, alternately with the *Royal William.* She was named the *Liverpool,* and was of 1150 tons, carrying engines of 404 horse-power. She sailed on October 20, 1838, and had got about one-third of the way across the Atlantic when it was found necessary to turn back on account of bad weather. She accordingly took refuge at Cork. A stay of ten days was made there, and she eventually arrived at New York on November 23.

The *British Queen,* as befitted her name, was launched on the Queen's birthday in 1838, and made her first voyage from London to New York in July 1839. She was commanded by Lieutenant Roberts, formerly of the *Sirius,* and was at that time the largest and fastest steam vessel afloat; and with Roberts in charge, it is not to be wondered at that she did some good work. Lieutenant Roberts, writing to a friend from New York, says in the course of a letter dated June 1, 1840: "I can only state there is not a faster seagoing vessel in the World, and time will tell. We have beat the *Great Western* every voyage this year and [word illegible] last year; therefore whoever gave you the idea of our Speed and Power were perfectly ignorant of Steam and Steam Vessels. I have made the passage from Portsmouth to New York shorter than ever performed, only 13 d. 11 h. from Pilot to Pilot. Let *Great Western* do that if she can, though she has ten hours' shorter distance to run. I sail at 1 P.M. this day

with full cargo and every berth taken, and sincerely do I wish to make a short passage." He adds: "I intend trying for some shore berth . . . but will not leave till I command the first iron vessel to steam across the Atlantic." This was not to be, however, for he was in command of the *President* when that ill-fated vessel left



THE "PRESIDENT."

New York with one hundred and thirty-six passengers on March 12, 1841. No trace of her has been found from that day to this.

The *President* was launched on December 7, 1839, on the Thames by the same builders, Messrs. Curling and Young. She was almost a sister ship to the *British Queen*, as far as appearance and general equipment went, but the engines of the second vessel were slightly more powerful.

The following comparative table, showing the dimensions of these vessels, was published in 1840:

THE "BRITISH QUEEN." FROM AN ORIGINAL PAINTING IN THE POSSESSION OF THE AUTHOR. p. 116

Dimensions.	*Great Western.*	*British Queen.*	*President.*
Extreme length (feet) . .	236	275	265
Extreme length under deck (feet)	212	245	238
Extreme length keel (feet) .	205	225	220
Breadth within the paddle-boxes (feet) . . .	35·4 in.	40	41
Breadth, including paddle-boxes (feet) . . .	59·8 in.	64	64
Depth of hold at midships (feet)	23·2 in.	27·6 in.	23·6 in.
Tons of space . . .	679½	1053	—
Tonnage of engine-room (feet).	641½	963	—
Total tonnage (tons) . .	1321	2016	1840
Power of engines (horses) .	450	500	540
Diameter of cylinders (inches)	73	77½	80
Length of stroke (feet) . .	7	7	7½
Diameter of paddle-wheels (feet)	28·9 in.	30·6 in.	31
Total weight of engines, boilers, and water (tons) .	480	500	500
Total weight of coals, twenty days' consumption (tons) .	600	750	750
Total weight of cargo (tons) .	250	500	750
Draught of water with the above weight of stores (feet)	16·8 in.	16·7 in.	17

They were square-sterned vessels, barque-rigged, and carried a long white funnel with a black top. The paddles were placed almost amidships, with the funnel abaft the paddle-boxes. The *Great Western* might be described as a four-masted barquentine. She had one funnel carried between the fore and main masts, and the paddles were set abaft the main-mast. All three vessels had engines of the side-lever type. Those of the *British Queen* were supplied by Napier from the Clyde, and those of the

President by Fawcett and Preston of Liverpool. The *Great Western's* engines were built by Maudslay, Son, and Field of London.

The *President* was built of oak with fir planking, her upper deck being flush from bows to stern. The stern was ornamented with the British and American arms, supported by the lion and eagle, appropriately painted. And for a figure-head she had a bust of Washington. The paddle-boxes were decorated with a five-point star. The first attempt to float the *President* was not a success owing to the tide not being high enough. A second attempt the following day also failed, but on the third day, Monday, December 9, 1839, she was floated, and towed out of the dock and down to Blackwall, where she was safely moored.

After the loss of the *President* in 1841, the British and American Steam Navigation Company sold the *British Queen* to the Belgians and retired from business altogether, leaving the *Great Western* practically in sole possession of the Atlantic. But, as the next chapter will show, this splendid isolation was not hers for long.

CHAPTER VI

DEVELOPMENT OF THE TRANSATLANTIC SERVICE

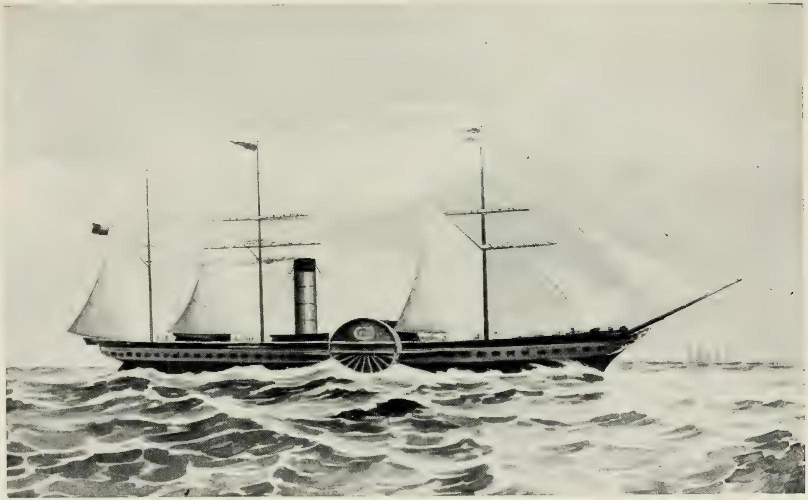
THE success which attended the voyages of the *Great Western,* and the manifest superiority of that steam-ship over the brigs which were then thought good enough to carry the mails across the Atlantic, induced the Government in October 1838 to invite tenders for the conveyance of the mails to America by steam vessels. Circulars were distributed broadcast, and one of them reached Samuel Cunard, a merchant of Halifax, Nova Scotia, who, as already stated, had entertained for many years the idea that the mails might be conveyed across the Atlantic more speedily than the "coffin brigs," as the Government's vessels were contemptuously termed, could carry them. From the year 1830, Cunard had been actively endeavouring to forward his scheme, but so little was thought of the powers of the steam-ship that the local merchants condemned his ideas as visionary and refused their co-operation. Accordingly he came to London but met with as little sympathy and financial support there as at Halifax. Fortunately for him and for the world, he was able to take a letter of introduction from the Secretary of the East India Company to Mr. Robert Napier, at that time the foremost steam-ship builder on

the Clyde, and probably in the world. Mr. Napier had just achieved a remarkable success in the construction of one of the earlier Isle of Man boats, the *Mona's Isle*, and the experiences through which she passed in triumph in one or two of her earliest voyages had greatly increased the fame of her builder. Mr. Napier himself used to say that he was largely indebted for his prosperity and reputation to the name made for him by the *Mona's Isle*. He introduced Cunard to John Burns of Glasgow, who was already extensively engaged in the steamer coasting trade between Scotland, England, and Ireland, and he in turn introduced Cunard to his Liverpool partner, David MacIver. After hearing Cunard's explanation of his project, the partners decided to support it, and such was their reputation for enterprise and for achieving success in everything they undertook that, through their instrumentality, the whole of the capital required, amounting to £270,000, was obtained. Backed up by Burns and MacIver, and with the promised support of Napier, Cunard was among those who tendered to the Admiralty for the conveyance of the mails once a fortnight between Liverpool, Halifax, and Boston. A tender was also offered by the Great Western Steamship Company, on whose behalf it was urged that their *Great Western* was already in existence and was prepared to undertake the work at once, and that the Cunard Company would either have to charter steamers or wait till they could be built. But the Government accepted the Cunard tender and a contract was signed for seven years, it being stipulated that four suitable steamers should be employed instead of three as originally required, and further, that the dates of arrival and departure should be adhered to. In consideration of these more onerous conditions the subsidy was increased from £60,000 to £81,000 per annum. The first four vessels of the Cunard Line, or as it was then formally known, "The British and North American Royal Mail Steam Packet

Company," were practically sister ships. There was little choice between them in size or power of engines, nor was there much difference in their internal arrangements. These vessels were built on the Clyde, the *Britannia* by R. Duncan, the *Arcadia* by John Wood, the *Caledonia* by C. Wood, and the *Columbia* by R. Steel. The orders were placed with four different builders so that the steamers might be ready as soon as possible. They were all launched in 1840, and all were fitted with the ordinary side-lever engines by Robert Napier, who had brought this type of engine to a high pitch of perfection. The *Britannia* was 207 feet long by 34 feet 4 inches broad, with a moulded depth of 24 feet 4 inches, and had a tonnage of 1154; her engines indicated 740 horse-power and gave her an average speed of 8½ knots on a coal consumption of 38 tons per day. Her cargo capacity was about 225 tons. Each of these vessels was fitted to carry 115 cabin passengers but none in the steerage. All were adapted for the transport of troops and stores in time of war. The first steamer actually sent across the Atlantic for the Cunard organisation was the *Unicorn*, which left Liverpool on May 16, 1840, for Halifax and Boston, and was then employed for several years between Picton and Quebec, in connection with the liners, and carried both mails and passengers. The first departure under the mail contract, however, was on Friday, July 4, 1840. That a Friday should be selected for the inauguration of the service, even though it was "Independence Day" in America, was received with much shaking of the head by those who clung to the sailors' superstition concerning the unlucky nature of Friday, but nothing untoward happened, and the choice of "Independence Day" for the first departure of the new line was hailed in America as a most graceful compliment. The voyage to Boston lasted 14 days 8 hours. The mail service was continued with conspicuous regularity for three years, when it was found that the traffic had in-

creased to such an extent that the four steamers were no longer able to cope with it. Accordingly in 1843 the *Hibernia* was added, and in 1845 the *Cambria*, sister ships of 210 feet in length between perpendiculars, 35 feet 9 inches beam, 24 feet 2 inches moulded depth, 1422 tons gross, and with engines of 1040 indicated horse-power, and an average speed of $9\frac{1}{4}$ knots.

In 1844 the *Britannia*, on arriving at Boston in February of that year in a particularly severe winter, became ice-bound. When the day came for her departure for Liverpool, the Bostonians showed their appreciation of the line and of the regularity of communication it maintained with England by cutting at their own expense a channel seven miles long and a hundred feet wide through the ice to liberate her, her sailing being only two days behind time. In 1847, even with the two extra ships, the company was unable to cope with the demands made upon it, and the commerce between the two countries had increased to such an extent that the Government felt bound when the time came for the renewal of the contract to require that the service should be doubled. It was stipulated that the company should provide a vessel of not less than 400 horse-power nominal and capable of carrying guns of the largest calibre. Its steamers were to leave Liverpool, calling at Holyhead if required, every Saturday for New York and Boston alternately, the Boston steamer touching at Halifax, and the New York one to do so also if required by the Admiralty. For these augmented sailings the subsidy was raised to £173,340 per annum, at which figure it remained to the end of 1867. This change necessitated the building of four new ships, namely, the *Niagara*, *Canada*, *America*, and *Europa*. They were 251 feet long between perpendiculars, 35 feet beam, 26 feet 3 inches moulded depth, and of 1825 tons gross register, and had engines of 2000 indicated horse-power, which gave



THE "BRITANNIA" (CUNARD, 1840).

p. 152

them an average speed of $10\frac{1}{4}$ knots. In 1850 the *Asia* and *Africa* were added to the fleet; they were sister ships, 266 feet between perpendiculars, 40 feet beam, 27 feet 2 inches depth, and of 2226 gross tonnage, and had engines of 2400 indicated horse-power, with an average speed of $12\frac{1}{2}$ knots. In 1852 the *Arabia* was built, 285 feet between perpendiculars, 8 inches more beam, with a depth of 29 feet, and a gross tonnage of 2402. Her engines developed 3250 horse-power and gave her an average speed of 13 knots.

The building of the *Arabia* marks the close of the first period in the history of the Cunard Line for, in 1855, the company began to build iron ships. She was intended to be a reply to the steamers of the Collins Line. For some reason or other the Americans made very few attempts to enter upon the transatlantic steam-ship trade until nearly the middle of the nineteenth century. Probably they were satisfied with the performances of their sailing clippers, as they had good reason to be, for the clippers often made faster passages than the early Cunarders. From 1838 to 1847 every Atlantic liner flew the British flag, but in 1845 the United States Congress passed an Act authorising contracts to be made with owners of American vessels, steamships preferred, for the regular transportation of the United States mails.

As an American writer says:

"This Act of 1845 is all-significant as the beginning of American steam-ship service in the foreign trade. Not until national protection was offered in the form of generous subsidies could our enterprising merchants and sailors see their way clear to enter into the rivalry with the State-aided steam fleets of Europe. The mail subsidy legislation of 1845 was a wise step and indispensable, but it was too long delayed. Congress should have acted five years before, when the first Cunarder, floated and maintained by a liberal subsidy from Parliament, came

across the ocean, beating the time of our celebrated packet ships. Individual resource could never compete with the great treasury of the British Empire." *

In 1847 the Americans made a determined effort to establish a fortnightly service between New York and Bremen, calling at Southampton or Cowes. This venture was known as the Ocean Steam Navigation Company, and though it had a contract for carrying the American mails in return for a subvention of 200,000 dollars, it ceased operations in little more than a year. It had two wooden paddle-steamers, the *Washington* and *Hermann*, built by Westervelt and Mackay for Mr. Edward Mills. Both were barque-rigged and carried a great spread of canvas.

The *Washington* was 236 feet in length, by 39 feet beam, 31 feet depth, and of about 2000 tons gross. The *Hermann* was slightly larger. The *Washington*, on her first voyage eastward in June of that year, was pitted against the *Britannia*, which the Americans expected to beat easily, but though the American boat had twice the engine-power, and the Cunarder was seven years old, the latter arrived two days ahead.

The New York and Havre Steam Navigation Company, another American enterprise, was founded in 1848 to carry the mails between those ports for a subsidy of 150,000 dollars per annum and to touch at Southampton. Its first vessel was the wooden paddle-steamer *Franklin*, 263 feet in length, of about 2184 tons, and 1250 indicated horse-power. She sailed on her first voyage in 1850, and was joined in the service by the *Humboldt*, a slightly larger vessel, in the following year. In December 1853 the *Humboldt* was wrecked near Halifax, and the *Franklin* went to pieces on Long Island in 1854. The company ordered two other vessels, the *Arago* and *Fulton*, which were launched in June 1855 and February 1856 respectively. They were rather larger than the *Humboldt*, but

* "The American Mercantile Marine," by W. L. Marvin.

instead of lever engines had oscillating cylinder engines, the cylinders being 65 inches diameter with a 10-foot stroke. Until they were ready the company maintained the service, after the loss of its earlier boats, with chartered vessels.

The New England Ocean Steamship Company, formed by Messrs. Harnden and Co. of Boston, placed the iron screw-steamer *Lewis* of 1105 tons on the service between that port and Liverpool in October 1851, but withdrew her the next year.

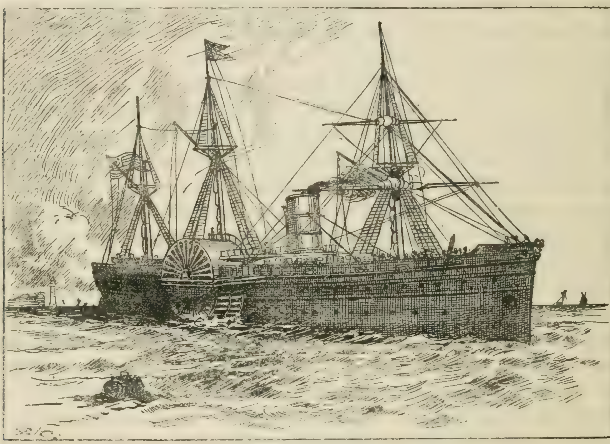
By 1850 there were no fewer than seven or eight lines of steamers trading between New York and Liverpool. The Cunard Company had eight of the finest steamers in the world, and the ninth, the *Africa*, was expected shortly to arrive from the builders at Glasgow.

An agitation had been maintained for some years in America for a subsidised American steam-ship service, which should surpass the British line. The Government at last was prevailed upon to promise financial support to a line of steamers under certain conditions, and the necessary legislation was passed by Congress in March 1847. The vessels were to be of the highest class, of great speed, and of superior passenger accommodation, and so fitted that they could be turned into war steamers at small expense. Mr. K. Edward Collins of New York, owner of the well-known Dramatic Line of sailing ships, so called because they were named after famous theatrical people, organised the line and was well supported by American capitalists and influential commercial men generally.

The Collins Line, as the organisation was called, undertook, by a contract signed in November 1847, to provide a mail service between New York and Liverpool, fortnightly in summer and monthly in winter, with five first-class steam-ships, for which 19,250 dollars per trip for twenty round trips, or 385,000 dollars a year, were to be paid, but as the first four ships built for the line were very much larger, swifter, and more expensive and more valuable to

the nation * than the exact terms of the contract required, the Government in 1852 increased the subsidy to 858,000 dollars a year.

Money was spent upon the Collins liners like water, and everything in every department was of a most costly and luxurious description. Indeed, so lavish was the



THE "ATLANTIC."

expenditure upon the Collins boats that even had they not met with the series of disasters which afterwards befell them, and had the line not been deprived by the United States Goverment of its subsidy for carrying the mails, it is doubtful whether it would ever have been a commercial success. Thus a description of the *Atlantic* says: "Her interior fittings are truly elegant, the woodwork being of white holly, satinwood, rosewood, &c., so combined and diversified as to present a rich and costly appearance. In the drawing-room the ornaments consist of costly mirrors,

* Marvin's "American Mercantile Marine."

bronze-work, stained glass, paintings, &c. On the panels between the stateroom passages are the arms of the different States of the Confederacy painted in the highest style of art, and framed with bronze-work.

"The pillars between are inlaid with mirrors, framed with rosewood, and at the top and botton are bronzed sea-shells of costly workmanship. In the centre of each are groups of allegorical figures, representing the ocean mythology of the ancients, in bronze and burnished gold. The ceiling is elaborately wrought, carved and gilded." The vessel was steam-heated, an improvement introduced for the first time in steam-ships.

The *Atlantic* left New York on April 27, 1850, with about a hundred passengers on board and a valuable cargo. Outside Sandy Hook she met some drifting ice which damaged her paddles, and she had to proceed at reduced speed across the ocean as the weather was too tempestuous to permit of the floats being repaired. On May 3, one of her condensers gave way, and the steamer was hove-to for forty hours, after which she resumed her voyage still at reduced speed. She arrived at Liverpool on May 10. The *Pacific* sailed from New York on May 25, and was followed by the *Arctic*, *Baltic*, and *Antarctic*. Their beam was such that they could not enter any existing docks at Liverpool, and a dock at the North End was therefore constructed for their accommodation.

Special interest attached to the arrival of the *Atlantic* owing to the presence in the river of the new Cunarder *Asia*, just built by Messrs. Steel at Greenock, and engined by Robert Napier. An opportunity was thus afforded of comparing these two representative vessels, as the *Asia*, outward bound, steamed past her rival and exchanged salutes.

The *Atlantic* and her sister ship the *Arctic* excelled in dimensions every steam-ship hitherto built. The length was 276 feet on the keel and 282 feet on the main deck,

beam 45 feet, breadth across paddle-boxes 75 feet, depth of hold 31 feet 7 inches, diameter of paddle-wheels 36 feet, diameter of cylinder 96 inches, stroke 9 feet; the side-lever engines were of 1000 horse-power, and the tonnage 2860. The saloons were 67 feet long by 20 feet wide, and the dining saloons 60 feet long by 42 feet wide.

Two remarkable points of difference between them and the Cunarders and all British steamers at that time were their rounded sterns and straight cutwaters without bowsprits. Powerfully engined though they were, they depended considerably on sail-power. Their paddles, like those of so many American steamers, were placed rather far aft, the idea being that a more uniform immersion of the blades was thus obtained. The Collins steamers were all built with flat floors (a departure in the shape of the hull to which considerable exception was taken but which was justified by events), long, wedge-like bows, and a long, easy run to the stern. The frames were of white and live oak, and the stout timbers were filled in solidly to the turn of the bilge. The huge oak keelsons were specially heavy under the boilers and engines. The planking was hard pine, metal-fastened below the water-line by copper bolts and above by galvanised iron. The frames were strengthened by a latticework of iron bands. Their wood construction was more massive than that of a line-of-battle ship. In his patriotic efforts to gain the Atlantic supremacy for his country Collins did far more than the Government required. The *Arctic* and *Atlantic* were built by W. H. Brown of New York, and their construction was superintended by G. Steers, who modelled the schooner-yacht *America*, the winner of the cup which has not yet been "lifted." Mr. Faron, of the firm Sewell and Faron, chief engineer to the United States Government, was the chief engineer of the company, and designed the *Arctic* and *Baltic* boilers. These were arranged with double furnaces and had lower water-spaces connected by

a row of tubes, round which the heated gas circulated; there was also a hanging plate which checked a too rapid flow to the funnel and increased the combustion. The *Arctic* burned about 83 tons of coal in 24 hours, which gave her a speed of 316·4 knots for the day. Her gross consumption was 87 tons when she covered 320 knots in 24 hours.

The funds subscribed were exhausted long before the construction of the boat was finished, and the Government not only granted the company's appeal for assistance, but went further and released the company from its obligation to build the fifth steamer. It increased the subsidy to 33,000 dollars per round voyage, but in return it demanded an increased speed, which, according to Mr. Bayard in Congress, would enable the Collins steamers to overtake any vessel they wished to pursue, and escape from any vessel they wished to avoid.

For some years the Collins Line seemed to have secured the premier position in the Atlantic trade. Its vessels eclipsed the Cunarders in size, speed, and luxury. The company, however, was expensively, almost wastefully, managed, and the steamers were run extravagantly. Great though its income was, its expenditure was greater. At its best the Collins Line never paid a dividend and its fall was hastened by two terrible disasters. Its first great calamity was the loss of the *Arctic*, which was rammed by the French iron steamer *Vesta* in a very thick fog between sixty and seventy miles from Cape Race. The *Arctic* was so well built that, although three large holes were torn in her side, through two of which the water poured, no apprehension was felt for her safety, and her captain sent a boat in charge of one of his officers to the other vessel to rescue those on board if necessary. One of the *Vesta's* crew was killed in the collision, and several others on board were injured. The rest of the crew and passengers made a rush for her boats and launched two,

one of which was swamped ; the other was occupied by two of the crew and several passengers, who, disobeying their captain's orders, cut their boat adrift and were soon lost to sight in the fog.

Meanwhile on the *Arctic* it had been discovered that the steamer was sinking. Preparations were made to save the lives of the passengers and crew by means of the boats. One of the tackles of the first boat to be filled gave way while it was being lowered to the water, and all her occupants, except one sailor who seized the other tackle and a lady who clung to him, were precipitated into the sea and drowned. Among those who lost their lives at this time were Mrs. Collins, the wife of the managing owner, and their son and daughter. The second boat was lowered without mishap and was provisioned and quickly filled with passengers. The water continued to pour into the ship, and she was headed for the nearest port, but in about a quarter of an hour the furnaces were put out. All the other boats but one left the ship, the exception being a large lifeboat which there were not sufficient seamen left on board to launch.

This boat is believed to have been filled by passengers, who thought that it might be left afloat when the ship went down. It is probable that it was so crammed that it had no chance of floating, and that it was sucked down with its occupants in the vortex caused by the sinking of the steamer.

The loss of life is variously stated. One version is that the *Arctic* had three hundred and sixty-five persons on board of whom only eighty-seven survived. An American writer, however, states: "The *Arctic* foundered with two hundred and twelve of her passengers and one hundred and ten of her crew." * The *Vesta* left St. Peter's the day before the disaster with one hundred and forty-

* "The American Mercantile Marine," by W. L. Marvin.

THE "ADRIATIC" (COLLINS LINE, 1857).

p. 160

seven passengers and a crew of fifty, of whom thirteen were reported missing when she reached St. John's.

The *Pacific*, a sister ship to the *Arctic*, was the next of the Collins liners to succumb to the perils of the sea. She sailed from Liverpool for New York in January 1856 and never reached her destination, and not a trace of her has been discovered to reveal her fate. The loss of these two splendid steamers within two years seriously crippled the Collins organisation.

Mr. Collins, to replace the *Arctic*, ordered the fifth steamer which was stipulated for in the contract with the United States Government at the time the line was started. This steamer, the *Adriatic*, like the other four vessels of the line, was in excess of the American Government's requirements, and was larger, speedier, and even more luxuriously fitted than any of her four predecessors. She was built by George Steers at New York and launched in April 1855. She was 355 feet in length, 50 feet beam, and 33 feet deep, with a gross tonnage of 4144 tons. Her cost was £240,000. It was hoped that this splendid vessel would retrieve the falling fortunes of the Collins Line, but in the following month a bitter attack was made in Congress upon the policy under which the line had been granted Government aid, and in consequence of this attack the subsidy to the line was reduced. The mail pay to the Collins Line was lessened by the withdrawal of the 473,000 dollars added in 1852 ; and the original subsidy of 385,000 dollars, or considerably less than half the amount on which Collins had been relying, was now to be paid to the company. This was further reduced to 346,000 dollars, and in 1858 the subsidy was withdrawn altogether. The line ceased operations at once. The *Adriatic* made one trip to Liverpool and, after lying idle there for some time, passed into the hands of the promoters of the Galway Line.

An equally unfortunate enterprise was the attempt to establish a line between Galway and America.

The project of connecting the west coast of Ireland with Newfoundland by a line of fast steamers has always had its attractions for those who are seeking to cut down the ocean voyage to a minimum, but so far as the passengers are concerned, the prospect of a long land journey from St. John's or Halifax to New York has always militated against the scheme. There are also the no less serious drawbacks of a trip across the Irish Sea to Dublin or other Irish port, continued by a railway journey to Galway before finally embarking on the ocean voyage. For the conveyance of mails this might be the fastest possible route, but until the Government adopt the exceedingly unlikely course of subsidising a line of mail packets for this purpose, the Galway–Newfoundland route has no prospect of becoming a serious factor in the North Atlantic traffic.

The first proposal to use Galway was made in 1851, when some of the Irish railway authorities and an American named Wagstaff visited the port, and in June of that year sent the steamer *Viceroy* to New York via Halifax. She was a wooden cross-channel boat and not suited for the work, and nothing more was done in the matter until 1857, when the project was revived by a Manchester man named Lever. Two steamers, the *Indian Empire* and *Propeller*, were chartered for the enterprise and sailed for New York via Halifax in the next year. In the autumn of that year, the Newfoundland Government contracted with the promoters of the line to carry the mails monthly from Galway to St. John's, and a service of six steamers was to be established. The British Government and the company entered into a contract whereby the company was to carry the mails from Galway to Portland (Maine), and to Boston and New York. Four steamers were ordered but were not up to the requirements of the postal authorities in respect to speed, and one or two were not perfectly seaworthy,

and the effort to maintain the service with chartered steamers not being satisfactory—only the last of the Collins liners, the *Adriatic*, which had been purchased, being able to run to stipulated time—the company, after a series of misfortunes which probably constitutes a record, went into liquidation, and the mail contract was cancelled, after resulting in a heavy financial loss to every one who had anything to do with it.

CHAPTER VII

THE DEVELOPMENT OF STEAM AUXILIARY

THE Atlantic was not the only scene of steam-ship enterprise in the early part of the nineteenth century, for merchants and shipowners recognised the importance of a faster and more regular communication between England and the Far East, and began to consider the desirability of employing steam-ships as soon as these vessels had shown that they could be used for sea voyages. At a meeting held in London in 1822 and attended by a number of merchants engaged in the Eastern trade, it was decided to form a steam-ship company to establish regular communication with India via the Cape of Good Hope, and to send Lieutenant Johnston to India to endeavour to interest merchants there in the scheme. The meeting naturally was in favour of the all-sea route by the Cape, but Johnston went to India via Suez, and became so convinced of the superiority of the latter route for mails and passengers and light merchandise that he became an enthusiastic advocate for its adoption. His mission to Calcutta was so successful that, in December 1823, Lord Amherst, the Governor, officially signified approval of steam-ship communication between the two countries, and recommended the Council to make a grant of 20,000 rupees to any British person or company who should, before the

end of 1826, "permanently establish steam communication between England and India, either by the Cape of Good Hope or the Red Sea, and make two voyages out and two voyages home, occupying not more than seventy days on each passage."*

Thanks to the generosity of the Rajāh of Oude a sum of 80,000 rupees was subscribed in India. The enthusiasm shown in the East for the project induced the promoters in London to charter the *Enterprise*, which was then being built by Messrs. Gordon and Co. at Deptford. Johnston returned to England, and when the *Enterprise* was completed he was appointed her captain. She was a wooden paddle-steamer, 122 feet on the keel, and 27 feet beam, and of 479 tons register. Her engines of 120 horse-power were estimated to give her a speed of eight knots per hour in good weather. Her boiler, which was of copper in one piece, cost £7000 and weighed about 32 tons. She sailed from London on August 16, 1825, and arrived at Calcutta on December 7. Her stoppages to replenish her bunkers occupied ten days, so that her actual travelling time was ninety-three days. She depended largely on sail. This voyage is of importance as it was the first made to India by a vessel built for ocean navigation and fitted with an auxiliary engine.

The *Enterprise* cost £43,000, and soon after her arrival, as the first Burmese war was then in progress, the Indian Government gave £40,000 for her.

The *Falcon*, a sailing ship of 176 tons, and having steam auxiliary, went to Calcutta in 1825, but it is to the steamer *Enterprise* that the honour belongs of having first reached Calcutta as a steamer. All that the voyage of the *Falcon* proved was that she arrived safely; her engines were not much used and her small size shows that even if she had been filled with coal she could not have steamed

* Lindsay's "History of Shipping."

all the way to Calcutta, nor were there sufficient coaling stations to enable her to do so.

The pilot of the *Enterprise* at Calcutta was Thomas Waghorn, then in the Bengal pilot service. The Calcutta Steam Committee, on behalf of the Indian Government, consulted him in 1827 on the question of the establishment of steam navigation between England and India, but though he visited a number of towns in England, his project of establishing a regular line of steamers via the Cape of Good Hope was not carried out. This, however, was not his only scheme.

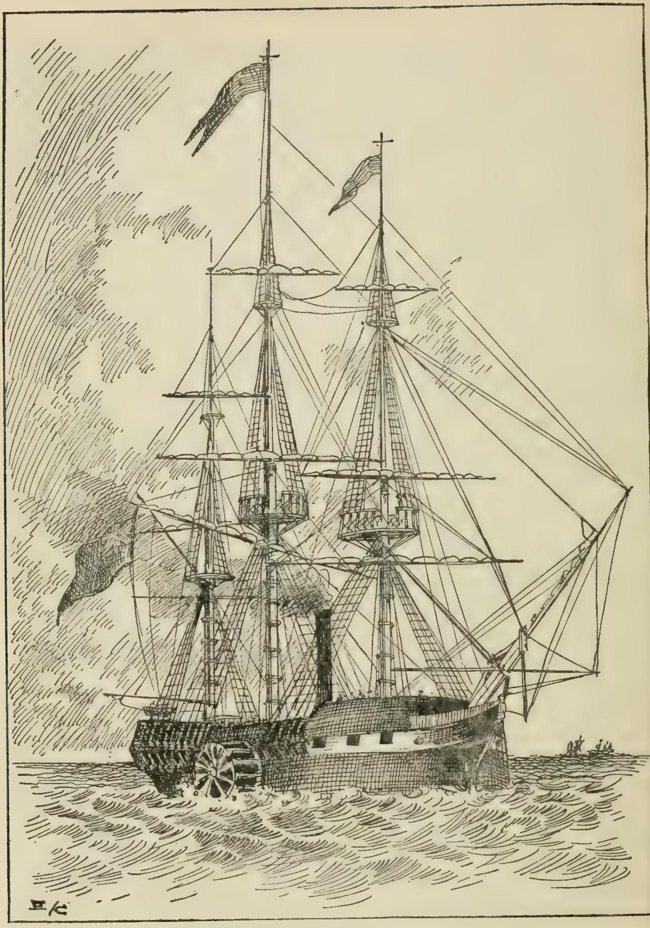
One of the difficulties in the way of establishing steamers on the Red Sea route was the high price of coal at Suez. Waghorn ascertained that coal could be brought to Suez by camel from Cairo at a reasonably cheap rate, and he therefore urged the adoption of this route. While he was still in England he heard that the East India Company intended to send the *Enterprise* from India to Suez, and he then offered to make a trial voyage. He was appointed courier to the East, and left London in 1829, undertaking to carry despatches to Bombay and return with the reply in three months, a time which was usually occupied by sailing ships in voyaging one way. When he reached Suez he found that the *Enterprise* had broken down on the way, and he accordingly took an open boat and began the journey down the Red Sea. Fortunately, the company's sloop *Thetis*, which had been sent to look for him, picked him up and took him to Bombay, and he returned to London in the appointed time. A steamer service down the Red Sea was then established. The *Hugh Lindsay* made the voyage from Bombay to Suez and back once a year until 1836, when two large steamers, the *Atalanta* and *Berenice*, took her place. During these years Waghorn devoted himself to overcoming the difficulties and dangers of travel across the desert from Alexandria to Suez.

"He associated with the Arabs, he lived in their tents, and gradually taught them that pay was better than plunder. He established a regular service of caravans, built eight halting-places between Cairo and Suez, and made what had been a dangerous path beset with robbers a secure highway. Before he left Egypt in 1841 he had a service of English carriages, vans, and horses to convey travellers." *

Meanwhile the service on the Cape route had been steadily improving.

By 1840, Messrs. Green of Blackwall owned a fleet of splendid East Indiamen fitted with auxiliary steam. One of them, the *Earl of Hardwicke*, which may be taken as typical of the others, had a steam-engine of 30 horse-power, working paddle-wheels intended to propel her in light airs and calms, such as are common in the region of the tropics. These paddles could be disengaged in one minute from the engine whenever it was desired to use sails alone. Although the *Earl of Hardwicke* was of 1600 tons, the space occupied by her boilers and engine was only 24 feet in length and 10 feet in width of the main deck, no part going into the hold or above deck. This engine in calm weather could give the ship a speed of five knots an hour on a coal consumption of three tons in twenty-four hours. In August 1840, in steaming from London to Spithead on her way to Calcutta, she beat the *Wellington* by twelve hours, the steam-engine working for upwards of forty hours. The ship was expected to make the voyage in 75 days, which, considering that she would have to go round the Cape, was quick work. She was a sister ship to the famous *Vernon*, with which the experiment of auxiliary steam for a regular East Indiaman was first made. The *Vernon* went from Calcutta to Spithead in 86 days, and for the first eight days and nights, in going down the Bay of Bengal, the wind was so light that she had to use her engines all the time. On the run from the

* "Dictionary of National Biography."



THE "EARL OF HARDWICKE."

Cape to Spithead she made the then shortest passage on record of 32 days, during which she used her steam nine days. The engines of the *Vernon* were constructed by Messrs. Seaward and Capel, of the Canal Ironworks, Limehouse, who were also builders of many other marine engines, some of large size, including that of the *Nicholai*, the largest steamer then belonging to Russia.

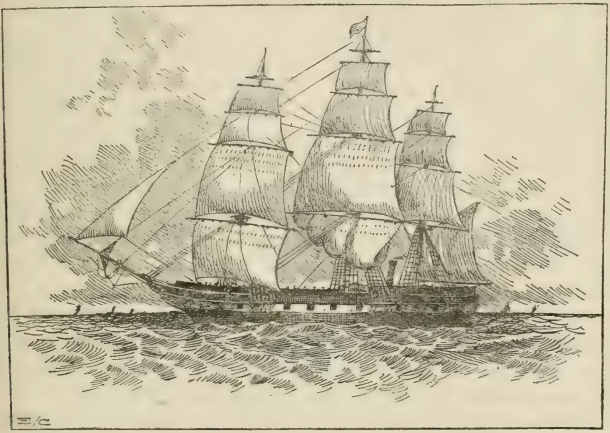
When the *Vernon* left Blackwall on her trial trip her engines gave her a speed of about three and a half miles an hour, against a strong wind. Both these vessels, like all the rest of the Indiamen, were full-rigged ships. They were built to be sailing ships with steam auxiliary, and therefore were necessarily very differently constructed from the vessels which were launched about the same time for the North Atlantic trade, such as the *Great Western*, the *President*, and the *British Queen*, all of which were steamers with sail auxiliary. The interdependence of the two means of propulsion must not be lost sight of in considering the naval architecture of the period. The Indiamen of Messrs. Green illustrated the adaptation of steam as an aid to sailing vessels, which even then had not attained their full magnificence and power, but which showed continual improvement in speed as fresh ones were built. This improvement was partly forced upon sailing-ship builders by the opinion, universally held at that time, that steam could never supersede sail for long voyages, owing to the difficulty of carrying enough coal. The steamers designed for the North Atlantic trade, on the other hand, were only intended for a short voyage—short, that is, in comparison with those made by the Indiamen. Consequently, the North Atlantic liners have developed as steamers first and foremost with sail auxiliary, and the latest flyers on this ocean would be of little use as flyers if trading to the Far East or Australia, because they could not carry enough coal and would have to stop frequently to

replenish their bunkers, while the liners of the southern and eastern oceans would be equally unable to compete on the North Atlantic routes.

Some sailing ships with steam auxiliary were, however, seen on the Atlantic. One of the most remarkable boats of the time was the *Massachusetts*. She arrived at Liverpool after a run of thirty days from New York, which she left on November 17, 1845. She had an Ericsson screw-propeller, which could be lifted when it was desired to run her under sail only. Her screw was merely an auxiliary and was only intended to be of use in calms or against light head winds. She was confessedly an experiment. Her engine-space meant one-tenth less cargo-space, but it was the owner's idea that, if the voyage were accomplished with so much greater rapidity than the ordinary packet ships could achieve as to recompense them for the loss of tonnage, the experiment would be a success. Her owner was Mr. R. B. Forbes of Boston, and she cost altogether about £16,000. She sailed from Liverpool for New York, beating such well-known sailing ships as the *Shenandoah* and *Adirondack* by thirteen days, and the *Henry Clay* by five days.

The United States *Nautical Magazine* in 1845 said: "Let it be distinctly understood that we do not call her a steamer or expect her to make steamboat speed except under canvas; her steam-power is strictly auxiliary to her canvas." The *Massachusetts* was the first ship of a line intended to run between New York and Liverpool under the American flag. Her length on deck was 161 feet, and her beam 31 feet 9 inches, with 20 feet depth of hold, and she was about 751 tonnage. Her full poop extended as far forward as the main-mast, and contained accommodation for thirty-five passengers. Her bow was very sharp. She carried what is known as a false bow, which increased her sharpness, and was filled in on somewhat original lines. In her equipment everything that could be devised was

provided. She carried lensed lights on each bow, and also aft between the main and mizzen masts. Her ventilators were similar to those on the Cunard steamers. Each stool, chair, and settee had airtight compartments, so that it could be used as a lifebuoy; she was well supplied with boats in case of accidents. The fact that



THE "MASSACHUSETTS."

she had an engine did not interfere with her sail equipment, for she was square-rigged throughout and carried skysails on all three masts. Her sail area was 3833 yards. A peculiarity of her rig was that all the masts were fidded abaft the lower masthead; but the advantages of this innovation were not found, in this or any other ship in which they were tried, to be very great, and it was not commonly adopted. It was thought that by fidding the masts in this fashion a vessel might be kept more steadily on her course when it became necessary for the sailors to reef or take in sail. She carried a condensing engine with

two cylinders, working nearly at right angles, of 26 inches diameter with a stroke of three feet. She had two "waggon" boilers, each 14 feet long, 7 feet wide, and 9 feet high, with a furnace to each, and a blowing engine and blower for raising steam quickly. The diameter of the propeller was nine and a half feet. It was made of wrought copper and composition metal, and could be raised out of the water when the steam-power was not required. This was effected by means of a shaft from the engine-room through the stern, above and parallel to the propeller shaft. The upper shaft revolving raised the propeller and placed it close against the flat of the stern, where it was secured with chains. The propeller shaft passed close to the stern-post on the larboard side, and rested in a socket bolted to the stern-post, and was further supported by a massive brace above. Messrs. Hogg and Co. of New York constructed the engines to Captain Ericsson's design. The rudder had the peculiarity of a "shark's mouth" cut across it. This is an opening or gap extending a considerable distance across the rudder so that the rudder itself shall not be impeded by the screw-shaft which extends beyond it, the upper and lower portions of the rudder passing above and below the shaft when turned in that direction. Several steam auxiliary vessels were thus fitted, but it was not long ere the plan was adopted of cutting away the dead wood in front of the rudder-post and placing the screw before the rudder instead of behind.

This enterprise was short-lived, as the vessel made but two round voyages and thereafter remained in American waters. A sister boat, the *Edith,* was purchased by the United States Government before she had made a voyage. The *Massachusetts* was chartered to carry American troops to Mexico in 1846, and continued in the United States Navy until 1870, when she was sold and converted into the sailing ship *Alaska,* under which name she made some good passages.

The *Vanderbilt*, also an auxiliary steamer, built by Simonson of New York for his uncle, Commodore Vanderbilt, in 1855, was 331 feet in length, and had a gross tonnage of 3360. She was probably the first and perhaps the only American-built vessel with two overhead beams to cross the Atlantic; certainly her appearance attracted no small amount of attention. Her two cylinders were each 90 inches diameter and 12 feet stroke; her indicated horse-power was 2800 and her boiler-pressure was as high as 18 lb. The engines were built at the Allaire works. She ran on the New York, Havre, and Cowes route until November 1860, besides going once to Bremen in 1858, and on the outbreak of war was presented by the Commodore to the United States Government. She was afterwards laid up and bought in 1873 by a San Francisco firm, who removed the engines and turned her into the full-rigged three-masted ship *The Three Brothers*; she was next bought by a British firm to end her days as a hulk at Gibraltar.

One of the last of the vessels carrying steam for admittedly auxiliary purposes only was the clipper *Annette*, built by Messrs. Russell and Co. in 1863. She was fitted with a screw and a small oscillating engine with cylinders 3 feet in diameter and 3 feet stroke, and a tubular boiler 9½ feet long by 13 feet high gave steam at 20 lb. pressure. Her screw was 11 feet in diameter with 22 feet pitch, and a universal joint connected it to the engine-shaft so that it could be lowered or raised as desired. The masts carried 1418 square yards of canvas.

The full-rigged, fast-sailing clipper ships, fitted with auxiliary screw propellers, found one of the finest representatives of their class in the *Sea King*, which was built at Glasgow for the trade with China, where several splendid vessels, fast under sail and carrying powerful auxiliary engines, were engaged. They were peculiarly suitable for those waters, for the coaling stations were few

and far between, and coal was expensive, and their engines consumed a great deal more fuel in proportion to results than do those of modern steamers. The *Sea King* was composite built; that is, she had an iron frame with wood planking. Her screw could be lifted when the wind was favourable, and her ability to show a clean pair of heels to most sailing craft afloat is proved by her making the passage home from Shanghai in seventy-nine days, or, after allowing time for coaling *en route*, seventy-four days. She was of 1018 registered tonnage, and her engines were of 200 nominal horse-power; she was 220 feet in length by 32½ feet beam, and 20½ feet depth.

Her career for a time was exciting. She was one of the many vessels bought by the agents of the Confederate States in 1864, nominally as a blockade-runner, but she became a privateer—pirate the Northerners called her—and as such she had the distinction of being the only vessel which carried the Confederate flag round the world. Her name was changed to *Shenandoah* when she was purchased; she was neither the first nor the last famous sailing vessel of that name. The last *Shenandoah*, the biggest wooden sailing vessel ever built in America, a four-masted barque, returned the fire of a Spanish gunboat in the recent Spanish-American War, and then out-sailed her. The commander of the *Shenandoah* of the 'sixties was James Tredell Waddell, whose record justified his appointment. He was formerly an officer in the United States Navy, and was wounded and lamed for life in a duel in 1842. He nevertheless served in the Mexican War and then commanded the American storeship *Release* at the building of the Panama Railway. All his officers and crew were down with yellow fever, but with a few convalescent seamen he sailed his vessel to Boston. He declined, in 1862, the offer to command one of the vessels in the bomb fleet then being fitted out to attack New Orleans, but instead he got through the blockade

from Annapolis to Richmond and joined the Confederate Navy. He was in command of the ram *Louisianá* when the Southern fleet was attacked and scattered by the Federal fleet under Admiral Farragut, and sank the *Louisiana* rather than let her be captured. Next he was ordered to take command of the *Shenandoah*, then being fitted out at Liverpool for a cruise in the Pacific. He commissioned his ship off Madeira in October 1864 and set sail for the south. He captured and either burnt or sank nine American sailing ships before he arrived at Melbourne on January 25, 1865, but the ship's stay was a short one, for it was expected an American vessel or two would be on her track, and she left Port Phillip on February 8, 1865. Three months later she began her destructive work among the whalers in the Okhotsk and Behring Seas and the Arctic Ocean. Three months after General Lee had surrendered at Appomattox Court-house, the *Shenandoah* continued her activity, and it was not until the British barque *Barracouta* was spoken that Waddell learnt that the war was ended. Waddell then sailed the *Shenandoah* to Liverpool and surrendered her to the British Government, by whom she was handed over in November 1865 to the United States Consul. During her career under Waddell's command she captured thirty-eight vessels, of which six were released on bond and thirty-two were sunk or burnt. She afterwards passed into the possession of the Sultan of Zanzibar, and some years later was lost with all hands in a gale. Waddell returned to America in due time and commanded the *San Francisco*, of the Pacific Mail Line, until she struck a rock and went to the bottom. All the passengers were saved and Waddell was the last to leave the ship.*

The other most notorious blockade-runner and commerce-harrier was the Liverpool-built *Alabama*, a wooden three-masted screw steamer, rigged as a barque; she

* Appleton's "Cyclopædia of American Biography."

was of 1040 tons register and 220 feet in length and had horizontal engines of 300 nominal horse-power, operating one propeller and giving her a speed, under steam, of nearly 13 knots, while with steam and sail together she could cover 15 knots. The story of her exploits and of her destruction by the United States wooden cruiser *Kearsarge* off Cherbourg in June 1864, and of the "*Alabama* claims," is too well known to need repetition here.*

The mail route between England and India via the Cape was admittedly slow; and it seemed possible to carry the mails by way of Suez in a much shorter time. The eastern half of this service was maintained in a very inefficient manner by the East India Company. The British Government had inaugurated in February 1830 its mail steam-packet service from Falmouth to the Mediterranean. Up to this date the mails had been carried in sailing brigs, although steam navigation with the Mediterranean had already been established and the steamers beat the sailing brigs by many days. The first of these Government steam packets was the *Meteor*, and the others employed included the *African*, *Messenger*, *Firebrand*, *Echo*, *Hermes*, *Colombia*, *Confiance*, and *Carron*.

The Dublin and London Steam Packet Company, under the management of Messrs. Bourne, decided in 1834 upon establishing a line of steamers between London and the Spanish peninsula. The proposed line was to be called the Peninsular Steam Navigation Company, and its first steamer was probably the *Royal Tar*. This steamer, by the way, had previously been chartered in 1834 to Don Pedro and then to the Queen Regent of Spain.

It is hardly correct, however, to describe these Admiralty vessels as warships, for the Admiralty steam vessels at that time were gunboats, or despatch vessels, steam for line-of-battle ships not being used until some years later.

* A good account may be found in Appleton's "Cyclopædia."

The Peninsular Company chartered a number of vessels for its early service, but it was not until 1837 that it commenced to despatch mail-packets regularly from London to Lisbon and Gibraltar under contract with the British Government, which at that time and for twenty years afterwards was represented by the Lords Commissioners of the Admiralty. This contract was tendered for by both the Peninsular Steam Navigation Company and a concern called the British and Foreign Steam Navigation Company, but the latter was unable to convince the Government that it possessed the resources, both financial and shipping, which would enable it to carry out the engagement. The Peninsular Company, on the other hand, was able to give the required assurance. The company undertook, in return for an annual subsidy of £29,600, to convey the mails monthly to the Peninsula. The pioneer vessel of this service was the *Iberia*, of 690 tons and 200 horse-power, which sailed in September 1837. Altogether the company had ten vessels, two of which were chartered from the City of Dublin Company.

The statement is often made that the steamer *William Fawcett* * was the first boat of the company; she was built in 1829 by Caleb Smith of Liverpool, and her engines were by Messrs. Fawcett and Preston, also of Liverpool; and after being used for some years as a ferry-boat on the Mersey she was placed on the Liverpool and Dublin route and may have been "chartered for a short time to the Peninsular Steam Navigation Company in 1835 or 1836, as she does not appear in the company's advertised sailing list for 1838." †

In 1839 the British and French Governments arranged that the Indian mails should be sent by way of Marseilles and thence taken by an Admiralty packet to Malta to be

* See the Frontispiece to this book.

† Kennedy's "History of Steam Navigation."

transhipped to another Admiralty packet for conveyance to Alexandria. As was to be expected, an arrangement of this sort, involving such possibilities of delay, did not last long, and the Government advertised for tenders for the mails to be carried between Alexandria and England, with calls at Gibraltar and Malta both ways. Four tenders were sent in, and that of the Peninsular Company, which offered to do what was required for £34,200, was accepted. The company also offered to charge reduced fares to officers travelling on the public service and to carry Admiralty packages for nothing.

The urgency of a more regular steam communication between England and India than was supplied by the sailing or auxiliary Indiamen was now being extensively discussed, and the Government was asked to subsidise a line of steamers between England and Calcutta which should make the passage in thirty days. The Peninsular Company offered to carry the mails between England and Alexandria with the two steamers *Great Liverpool* and *Oriental*, and in 1840 the company was incorporated by Royal Charter under the name of the Peninsular and Oriental Steam Navigation Company, with a view to the extension of its operations to the Far East. The *Great Liverpool* was of 1540 tons, and had been built for the Liverpool and New York trade, and the *Oriental* was of 1600 tons and 450 horse-power. The company was afterwards requested to place two smaller steamers on the Malta and Corfu branch of the mail service, and did so for no less than £10,712 below what it had cost to maintain the Admiralty packets.

The inadequate service maintained between Calcutta and Suez had given rise to many complaints, and at last, after considerable pressure had been brought to bear on the East India Company by the Government in London, the former consented to enter into a contract with the P. & O. Company for the conveyance of the mails between

THE "HINDOSTAN" (P. & O. COMPANY, 1842).

p. 178

these two points. The company despatched its first steamer to India in September 1842, this being the *Hindostan*, a fine vessel of 2017 tons, and 520 horse-power. She was a three-masted vessel, and carried square sails on the foremast, and of her two funnels one was set before and the other abaft the paddles. Her departure was regarded as of national importance, and the warships she passed as she left port were manned in her honour. She was placed on the route between Calcutta and Suez, with calls at Madras and Ceylon; and as other steamers followed, the company was soon able to contract for the conveyance of the mails monthly from Ceylon to Hong-Kong, with calls at Penang and Singapore, for a subvention of £45,000. The company received £115,000 for its service between Calcutta and Suez. The Eastern services were attended with no little difficulty. At Suez and Aden fresh-water supplies had to be organised, and coaling stations, docks, and store establishments had to be established wherever necessary.

The scramble over the isthmus of Suez, whence came the name of the "overland route," was one of the great drawbacks of this way to the East, and many persons preferred to travel to India by way of the Cape. In spite of its name the overland route was mostly a waterway, for the Mahmoudieh Canal enabled the P. & O. Company to transport its passengers and goods from Alexandria to the Nile, where they travelled by steamer to Cairo, and the land portion of the journey was rather less than 100 miles across the desert from Cairo to Suez. Caravans, sometimes numbering more than three thousand camels, were employed to convey a single steamer's loading between Suez and Cairo. In passing from the Red Sea to the Mediterranean port every package had to undergo three separate transfers.

"For nearly twenty years this system of working the company's traffic continued in operation, but it sufficed

for carrying on a trade which, for the value of the merchandise in proportion to its bulk, has, it may safely be said, never been equalled. It attained sometimes the annual value of forty millions sterling."*

The East India Company's service between Suez and Bombay was as bad as that formerly maintained with Calcutta, owing to indifferent management and unsuitable steamers, and as it cost about 30*s.* per mile, whereas the P. & O. maintained its services to India and China for 17*s.* per mile, there was a renewal of the agitation for the service to be taken out of the control of the East India Company and entrusted to a concern which could work it better and more economically. Parliament in 1851 supported the agitation, but the East India Company would not give way until the fates were too strong for it; one lot of Bombay mails went to the bottom in a native sailing vessel in which they had been placed at Aden, as the company had no steamer ready for them at Suez. At the request of the Government, the P. & O. Company agreed to take over this service for a subvention of £24,000 per annum, as against the £105,000, or thereabouts, which the old arrangement had cost.

The P. & O. Company opened its Australian service in 1852 as a branch line, but this connection proved so beneficial to the company and the Australian Colonies alike, that in course of time it was made a main-line service, to the mutual advantage of the company and the Colonies. So many of the company's steamers were employed in the Crimean War and during the Indian Mutiny for the Army, that the Australian portion of the service was dropped for some time.

In 1852 the company added eleven vessels to its fleet, including the celebrated *Himalaya*, then the largest steam-ship afloat and the fastest ocean-going vessel, with

* P. & O. Handbook, 1905 edition.

H.M. Troopship "Himalaya" in Plymouth Sound. (The "Royal George," 120 Guns, in background.)

p. 180

the possible exception of a few on the North Atlantic. Eleven of the company's steamers were chartered to the Government as transports during the Crimean War, and one of them, the *Colombo*, was nicknamed *Santa Claus* when she arrived at Sebastopol one Christmas Eve with presents and sorely needed stores and provisions for the troops.

The East India Company in 1855 asked for tenders for the Calcutta and Burmah mails, and an agreement was entered into with Messrs. McKinnon and Co. of Glasgow, but the steamers they employed were unsuitable and small and the enterprise was a failure. Two steamers, the *Baltic* and *Cape of Good Hope*, were sent out for the work, and fortunately for the owners were acquired soon afterwards as transports during the Indian Mutiny.

This undertaking was known as the Calcutta and Burmah Steam Navigation Company, and was at that time purely local in its operations. Its steamer the *Cape of Good Hope* was lost in a collision in the Hoogly, and another steamer of the line was wrecked while on her way out to India on her first voyage while off the coast of Ireland.

However, the company changed its name in 1862 to the British India Steam Navigation Company, Ltd., and notwithstanding its inauspicious start under its old name, it has grown apace and is now one of the principal lines trading between England and the Eastern Hemisphere.

The opening of the Suez Canal in 1869, which threatened serious financial loss to the P. & O. Company, proved of great benefit to the British India Company. The P. & O. "for thirty years had built up and depended for existence upon the only traffic which was possible in connection with the transit through Egypt, viz., the conveyance of passengers and goods at rates which were necessarily high, owing to the conditions under which the

work had to be carried on. These conditions and the rates depending on them were swept away by the opening of the canal, and the financial consequences were such that for some time the future existence of the company appeared to hang doubtfully in the balance. The company's work had therefore to be reorganised, and a new fleet procured with what diligence was possible under the adverse condition of reduced, and at one time of vanished, profit."

This extract from the company's Handbook is interesting, but considering how long the Suez Canal was in building, the company can hardly be said to have made any undue haste in anticipating the coming change.

The difficulties of the P. & O. Company, caused by the opening of the Suez Canal, were increased by the objections which the Post Office raised to the use of the canal for the passage of the mails instead of the Egyptian Railway, but it gave way on this point "for a pecuniary consideration, that is to say, for a sensible abatement of the subsidy, which was not an easy matter to arrange at a time when the company was struggling for existence. However, the company made some concession, and it was finally arranged that the heavy mails which were then sent from England by sea should in future be carried by the Suez Canal, but it was not till 1888, when the company had reduced their charge for the conveyance of the mails by nearly £100,000 per annum, that the accelerated mais sent via Brindisi were also transferred to the Canal Route. The company's connection with the Overland Route through Egypt, which had existed for half a century, was then finally closed."*

The Union Line was founded in 1853 as the Union Steam Collier Company, and it made a start with five

* P. & O. Handbook.

H.M. Troopship "Himalaya."

p. 182

little steamers, the largest of which were the *Dane* and *Norman* of 530 tons. The outbreak of the Crimean War, and the consequent withdrawal of the P. & O. steamers from the Southampton and Constantinople service for use as transports, saw the Union vessels placed upon that service till they also were engaged as transports, and a sixth vessel was acquired. When the war was ended, the steamers were placed for a time in the Southampton and Brazil trade, but it was not a very profitable venture and they were diverted to the South African trade, the company receiving a subsidy of £30,000 a year for five years for carrying the mails to and from the Cape of Good Hope. The first sailing was made by the *Dane* in September 1857, and the sailings thereafter were monthly. The subsidy was increased by £3000 the following year on condition that calls were made at St. Helena and Ascension.

In 1857, Rennie's "Aberdeen" Line, after having been for many years in sail, went in for steam and despatched its first steamers, *Madagascar* and *Waldensian*, from London to South Africa, carrying the mails between Cape Town and Durban. These are stated to have been the first steamers on the South African coast. The *Madagascar*, of 500 tons, was commanded by Captain George Rennie. Like all the long-distance steamers of her time, she carried a large spread of sail, but her engines, like those of most of her contemporaries, were calculated to be able to render her independent of the wind if it did not happen to be suitable, and therein they marked a great improvement upon those of an earlier type, which were merely assistants to sail. The steamers built in the later 'fifties were intended to place reliance principally on their engines, because of the regularity of passage thereby secured, rather than upon their sail-power; so that even by this time, although the vessels were described as auxiliary steamers, a more correct description would have

been that they were steam-propelled vessels carrying a large spread of canvas.

In March 1859, Messrs. J. and W. Dudgeon issued a circular on the subject of steam navigation direct to Calcutta round the Cape, pointing out that "steam hereafter will be almost exclusively employed in the transport of goods between East India and Australia and the United Kingdom may be taken for granted; this is merely a matter of time." The circular continued that the Cape route would certainly be simple and safe, and therefore superior to the overland route, especially if it could be rendered expeditious and profitable. The conditions required that vessels of not less than 5500 tons, builders' measurement, be supplied at a total cost per vessel of £150,000; the voyage, it was anticipated, would take thirty or thirty-five days, or only a couple of days more than the overland route. As a correct forecast of the size of vessels which until a few years ago conveyed the great bulk of the merchandise between Britain and the Far East, this statement is interesting and shows how accurately the needs of the traffic were estimated.

In 1855 Messrs. A. and J. Inglis of Pointhouse, Glasgow, entered into a contract "with a degree of boldness which only complete success could have justified. They undertook to build the steamer *Tasmanian* to the order of the European and Australian Steam Navigation Company. The machinery, of over 3000 horse-power, was at that time considered of the largest size, and to undertake the erection of it in a little wooden shop barely twenty feet high, and furnished with a fifteen-ton crane, was almost heroic. The soleplate of this set of engines weighed 40 tons, and had to be lowered with screw-jacks into a pit dug out to give height under the travelling crane. Messrs. Inglis actually built up the crank-shaft themselves, working the material in the smithy. The

THE "NORMAN" (UNION-CASTLE LINE, 1894)

p. 184

Tasmanian proved one of the fastest screw steamers built up to that time, having easily attained over 14½ knots at Stokes Bay. Her consumption of coal, about three pounds per indicated horse-power, was for that day extremely moderate. The engines were constructed with three cylinders, had a built crank-shaft, valves at the side, variable expansion, steam reversing gear, a built propeller, and other fittings which are still reckoned in that comprehensive term, 'all modern improvements.' The engines worked most successfully until the general adoption of the compound engine made so many admirable contrivances obsolete." * Shortly after building the *Tasmanian*, Messrs. A. and J. Inglis began to build for the British India Company with excellent results to all concerned, and since then they have constructed many vessels for this famous company.

In July 1858, owing to the failure of the European and Australian Mail Company, the Royal Mail Steam Packet Company agreed with the Lords Commissioners of the Admiralty to continue the Australian mail service, and entered into a mail contract for eight months for a subsidy at the rate of £185,000 per annum, giving a monthly sailing, with Government guarantee of £6000 a month under certain circumstances if there were loss in the working.

The line of mail packets between Panama, New Zealand, and Sydney was maintained in connection with the R.M.S.P. service to the West Indies and Panama with the mails, and was regarded as a useful alternative to the line from Point de Galle to King George's Sound and other Australian ports. The Panama, New Zealand, and Australian Royal Mail Company was granted a yearly subsidy of £9000 for the main line, excluding the intercolonial services, the amount to be increased to £110,000 if the New Zealand Government should afterwards

* *Engineering*, July 30, 1897.

stipulate for a higher rate of speed. The *Ruahine*, the second vessel laid down, but the first completed for this line, was constructed by Messrs. Dudgeon, and was a brig-rigged steamer of 1500 tons, and was 265 feet long, 34 feet beam, and 25 feet 7 inches deep, and had engines of 354 nominal horse-power, driving Dudgeon's double screws. She had accommodation for 100 cabin passengers, 40 second cabin, and 65 in the steerage. She left London on her maiden voyage in April 1865, and made the voyage to her final Australian port in 63 days, of which she was only 55 days actually at sea, the other days being accounted for by calls *en route*. She was expected to make the passage between Panama and Wellington in 25 days.

The Pacific Steam Navigation Company, which celebrated the seventieth anniversary of its foundation in February 1910, owes its inception to the enterprise of William Wheelwright, an American, who was born at Newburyport, Massachusetts, in 1794, and died in London while visiting England in September 1873. He began his business life as a printer's apprentice, but soon went to sea, and by the time he was nineteen years old he was in command of a ship. He was captain of the *Rising Empire* when she was wrecked in 1823 off the Plate, and then shipped as supercargo on a vessel bound from Buenos Ayres to Valparaiso. The following year he was appointed United States Consul at Guayaquil and five years later removed to Valparaiso. With the view of extending American commerce and supplying better communication than then existed on the coast, he established in 1829 a line of passenger vessels between Valparaiso and Cobija, and in 1835 decided to place steamers on the west coast. It took him three years to obtain the necessary concessions from the South American countries concerned. American capitalists fought shy of his proposals, so in 1838 he came to England, where he was well received. His plan in-

cluded the adoption of the route across the Isthmus of Panama, though many years passed before this portion of it was realised. The necessary capital, £250,000, was raised in 5000 shares of £50 each, and a Royal Charter was granted on February 17, 1840. The two wooden paddle-steamers, *Chili* and *Peru*, were built for the line by Messrs. Curling, Young and Co. of London in 1839; they were sister vessels and were each about 198 feet long by about 50 feet over the paddle-boxes and were brig-rigged, of about 700 tons gross, and had side-lever engines of about 150 horse-power by Miller and Ravenhall. In 1840 they passed through the Straits of Magellan, Mr. Wheelwright being on board one of them, and received a series of national welcomes along the west coast. Coaling difficulties were serious, and at one time the boats were laid up for three months. At last, in order to secure a sufficient supply, Mr. Wheelwright began to operate mines in Chili. These vessels were not, as has often been stated, the first steamers to enter the Pacific, for in 1825 a small steamer, the *Telica*, belonging to a Spaniard, tried to trade on the coast, but was a financial failure and the owner blew up his vessel and himself with gunpowder at Guayaquil.

The Pacific Steam Navigation Company came near to being a failure, but held on, and in 1852, having secured a further postal contract, the company added four larger vessels of about 1000 tons each to its fleet, all of them being employed on the purely local service.

In 1852 there was a bimonthly service from Valparaiso to Panama, where the line had a connection across the isthmus with the Atlantic navigation. In 1855 the Panama Railway was opened, and the company's activity was greatly increased. In the following year also the company adopted the compound type of engines, which was only just brought out, being, it is stated, the first

steam-ship proprietary to do so for ocean traffic, and influenced probably by the immense saving thereby made in fuel consumption.

Contracts were made in 1848 by the United States Government with George Law, an American financier and shipowner, and his associates, to carry the American mails from New York to Aspinwall on the Isthmus of Panama, and with C. H. Aspinwall to convey the mails on the Pacific side from Panama to San Francisco and ports beyond. This was the inauguration of the Pacific Mail Line, and its first steamer, the *California*, sailed from New York in October of that year for San Francisco. The gold rush was at its height and the demand for the steam-ships was so great that she was quickly followed by the *Pacific* and *Oregon*, the latter built in 1845. All three were wooden paddle-steamers about 200 feet long and of nearly 1060 tonnage, and made good passages round Cape Horn.

With the arrival of the three steamers on the west coast, the transisthmian route was adopted for passengers and light merchandise, and the *Ohio* and *Georgia*, which Law had built, carried, in 1849, the first passengers by steam-ship to the isthmus from New York.*

When the Pacific Mail Company established a competing line between New York and Chagres, Law placed an opposition line of four steamers on the Pacific. In 1851 the rivalry was ended by his purchasing their steamers on the Atlantic side, and selling to them his new line from Panama to San Francisco.

Twenty-nine fine steamers, of a total of 38,000 tons, were built in ten years for the two branches of the Californian trade, and the Pacific Mail Company, representing an amalgamation of the Law and Aspinwall interests, assumed the position, which it has retained ever since, of the leading American steam-ship company in the

* Marvin's "American Merchant Marine."

Pacific. The company is asserted to have carried 175,000 passengers to the "golden west" in that decade and to have brought back gold to the value of forty million pounds sterling.

"The Administration, which was so liberal in helping the Collins Line to beat the British, contracted with the Pacific Mail Steamship Company, formed in 1847, for a service from Panama to Astoria, and from New York, Charleston, and New Orleans to Havana, from which port the company already had a connecting line to Chagres (Colon), thus completing the connection between the coasts. . . . The speed from Panama to San Francisco was more than ten miles an hour. Thus the United States had line traffic of first-class character connecting its remote coasts before it had an American line to Europe. At Panama it connected with the Pacific Steam Navigation Company, giving service to Peru and Chili, so that before the middle of the century the Pacific had at least 5000 miles continuous steam line traffic." *

The Royal Mail Steam Packet Company in the seventy years of its existence has played an eventful part in the history of the mercantile marine. Its earliest steamers were wooden paddle-boats, and were among the best, but in spite of their excellence they experienced an extraordinary run of misfortunes, and losses by fire and wreck marred the records of the company for several years after its incorporation in 1839. Its charter has been revised and extended from time to time, one clause being that the whole of the share capital must be British owned, and the management British. In its long career it has served almost every port in the West Indies with the mails, and has had no less than fifty-three contracts. At one stage its management was subjected to some strong criticism, but under its present management the company has

* "The Ocean Carrier," by J. Russell Smith.

prospered by leaps and bounds, affording an excellent illustration of the value of well-directed energy and enterprise.

The history of the Royal Mail Steam Packet Company is the record of the development of the steamship connection between this country and the West Indian Colonies. In 1840 the original contract was entered into with the Admiralty Commissioners for executing the office of Lord High Admiral for the commencement of the mail service to the West India Colonies, the Spanish Main, New York, Halifax, Mexico, Cuba, &c.

The conditions under which the mail contract was to be carried out were somewhat onerous. One was that the company should receive on board every vessel a naval officer or other person and his servant to take charge of the mails, and that every such person should be recognised and considered by the company as the agent of the Commissioners in charge of the mails. He was empowered to require a strict observance of the contract and "to determine every question whenever arising relative to proceeding to sea, or putting into harbour, or to the necessity of stopping to assist any vessel in distress, or to save human life." A suitable first-class cabin was to be furnished at the company's expense, and appropriated to the officer's use; he was to be victualled by the company as a first-cabin passenger without charge, and should he require a servant, such servant, "and also any person appointed to take charge of the mails on board," should also be carried at the company's cost. From which it would appear that some very comfortable places were at the disposal of the Admiralty. The Admiralty representative was also to be allowed a properly manned four-oared boat to take him ashore whenever he felt inclined to go. Various penalties were applicable for breaches of the contract, the fines ranging from £100 for doing something of which the official did not approve to

£500 for a delay of twelve hours, and a further £500 for every twelve hours "which shall elapse until such vessel shall proceed direct on her voyage in the performance of this contract," so far as the Barbadoes mails were concerned, and of £200 for mails for other places. Another stipulation was that naval officers were to be charged only two-thirds of the ordinary fares as passengers. The company's subsidy was to be £240,000 per annum.

The company's first steamer, the *Forth*, was launched at Leith in 1841, and on January 1, 1842, the West Indian mail service was established by the sailing of the steamer *Thames* from Falmouth. On completion of her voyage she proceeded to Southampton, which has been the terminal port of the company ever since. The company organised transit by mules and canoes across the Isthmus of Panama in 1846, opening up the route via Colon and Panama to the Pacific ports.

In the same year the Admiralty, in order to make a through mail communication between England and the West Coast of South America, contracted with the Pacific Steam Navigation Company for the carrying of mails from Panama in connection with the R.M.S.P. service to Colon, and the next year the latter company made through arrangements with the Pacific Steam Navigation Company and the Panama Railroad Company for traffic from Southampton (via Panama) to the South Pacific Ports.

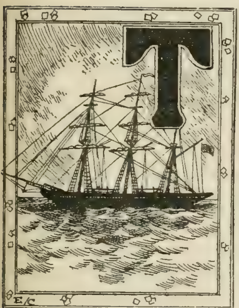
Enough has been written to indicate in some detail the progress made in steam-ship construction. Wood was the material chiefly used until near the middle of the nineteenth century. Iron then began to take its place and the screw-propeller to supersede the paddle-wheel. Some iron screw steamers have already been mentioned, but this was inevitable, as no hard and fast line can be drawn across the history of invention and commercial

enterprise, to separate iron from wood and screw from paddle. The screw propeller had actually been tried by Stevens in 1802, and iron boats for inland waters were built as early as 1787.

But the general adoption of iron for building steamships and of the screw for the propulsion of ocean-going ships marks a new era in the history of steam-ship building.

CHAPTER VIII

EXPERIMENTAL IRON SHIPBUILDING



THE suitability of iron for shipbuilding purposes had been admitted long before the construction of wooden vessels reached its limit as a profitable undertaking. The first experiments with iron were on a small scale, but they demonstrated the theory of displacement, so that observant marine builders had it borne in upon them that flotation depended rather upon the displacement of the floating body than upon the specific gravity of the material for which the floating body was constructed. But the general public was unconvinced, and making deductions from a limited knowledge of the subject, cried: " Put a piece of iron on the water and see if it will float." With the increase in the size of wooden steamers and sailing vessels there came the demand for stronger, heavier, and thicker timbers for all parts. This meant so much more unremunerative weight of hull to be carried and so much less space available in proportion to the size of the vessel; so that in time the limit of carrying cargo at a profit and of staunchness of construction was bound to be reached.

In wooden steam-ships the limit of length was about 275 feet over all; the *Great Eastern*, built in 1858, proved

that there was apparently no limit to the length of the iron ship.*

This length has been exceeded by a few American wooden sailing vessels. The largest square-rigged vessel ever built in America, the shipentine *Shenandoah*, was of wood; her dimensions being 299·7 feet, beam 49·1 feet, and depth 19·9 feet; 3407 tons gross and 3154 net. She was built at Bath (Maine) in 1890 for Messrs. A. Sewall and Co., and was acquired a couple of years ago by the United States Government for a hulk at San Francisco, but has since been recommissioned. Though not a clipper in the strict sense of the word, she was a fast sailer and is sometimes called the last of the Yankee wooden clippers.

As wooden hulls were made larger they displayed a tendency, especially when they were built to carry propelling engines, to sag or hog, that is to say, to droop amidships or at the ends. This difficulty was ingeniously overcome in America, where wooden steamers were built longer and lighter and shallower than in Great Britain to suit the vast rivers of that country, by Stevens, who introduced his hogging frame, to which fuller reference has been made in Chapter II. But in the steamers of Great Britain, which were entirely for deep sea, this arrangement was impossible, and the solution of the difficulty had to be found in the use of a material other than wood.

The only substitute was iron. The change from wood to iron meant a saving in weight of hull of about thirty to forty per cent., while it is asserted that in a few cases there has been an even greater difference. The saving also meant that the difference in weight could be added to the weight of the cargo, without increasing the displacement; while another advantage was that the beams and ribs and stringers were of smaller dimensions, and the space thus gained, added to that obtained by the substitution of thin

* Mr. John Ward's Presidential Address to the Institution of Engineers and Shipbuilders in Scotland, 1907.

iron plates for wooden planking several inches thick, also very considerably increased the space available for the stowage of cargo. Practically every part of a ship was of wood until 1810, in which year the scarcity of oak resulting from the extensive felling of trees in the English forests compelled the use of iron for the knees or connections between the deck-houses and the ribs, and for the breast-hooks and pillars of ships.

An experimental iron barge was made in 1787 by J. Wilkinson the ironmaster.

As early as 1809 it was proposed by Richard Trevithick and Robert Dickenson that ships should be built of iron, but the proposal was received with derision. The *Vulcan*, built in 1818 at Faskine near Glasgow, is, so far as is known, the first iron vessel constructed for commercial purposes, and so well was she built that as recently as 1875 she was engaged in transporting coal on the Forth and Clyde Canal, and looked little the worse for wear. Her builder was one Thomas Wilson.

The first iron steamer, however, was the *Aaron Manby*, built in 1821 at the Horseley Iron Works near Birmingham, to the order of Captain Napier, afterwards Admiral Sir Charles Napier, and Mr. Manby. She was put together at Rotherhithe, and in May 1822 at Parliament Stairs took on board a distinguished party of naval officers and engineers, whom she conveyed for a trip of several hours up and down the river between Blackfriars and Battersea. A contemporary newspaper described her as "the most complete specimen of workmanship in the iron way that has ever been witnessed." This little vessel was 106 feet long and 17 feet broad, and carried a 30-horse-power engine. Her wheels were of the type known as Oldham's revolving bars. Her only sea voyage was to France under the command of Captain Napier. Upon arrival she was employed on the Seine or Loire. Another iron vessel intended for navigation on the Seine was

shortly afterwards made in this country, and the parts sent to France to be put together.

Little appears to have been attempted in this country for some years in the way of iron shipbuilding, although in Ireland three or four small iron sailers or steamers were constructed for inland navigation purposes. But in 1828 John Laird of Birkenhead had his attention directed to iron shipbuilding, and completed his first iron vessel there the following year. Other builders followed where he showed the way, and in less than three years there were shipbuilders on the Thames, Clyde, and east coast of Scotland who were launching iron vessels, the great majority of which were sailing ships. The famous yards on the Cheshire side of the Mersey remained for some time the headquarters of the new industry. The first iron vessels for the United States—not the first iron-plated vessels, and this is a distinction which should be noted—were launched there, and so immediate was the recognition of the advantages of iron ships over wooden ones that by 1835 there had been built at Laird's the first iron vessels for use on the rivers Euphrates, Indus, Nile, Vistula, and Don. They were small compared with the wooden vessels afloat.

The *Garry Owen*, built in 1834 by MacGregor, Laird and Co. of iron, was only 125 feet in length, 21 feet 6 inches beam, with two engines totalling 90 horse-power. There were no Lloyd's rules as to scantlings for iron steamers in those days, and builders put in as much material as they thought necessary for the strength of the vessel, which usually meant a liberal allowance. The *Garry Owen* was not much to look at, but she was very strongly built, a circumstance which had a great deal to do with the development of iron steam-ship building. She nearly came to grief on her first voyage, for she was overtaken by a violent storm, which drove her and several other vessels ashore. These others were of wood. Some of them were

soon pounded to pieces by the heavy seas, and those that escaped total loss were badly damaged; but the *Garry Owen*, though bumped and dented somewhat, was able to get afloat again little the worse and return under her own steam.

If a steamer strongly built of iron could survive a storm and stranding which ended the careers of several wooden ships of larger dimensions, it was admitted that there was no valid reason why other iron vessels should not prove equally safe, especially if they were larger. It was considered that iron steamers might find useful employment in short voyages, and several were built.

One of the chief of these vessels was the *Rainbow*, launched in 1837 for the London and coastal trade. She was 185 feet long by 25 feet beam, and of 600 tons, with engines of 180 horse-power.

The use of iron in construction was not the only factor in the tremendous change which was coming in shipbuilding. A new form of propulsion was necessary, and it was found in the screw propeller.

Before considering this, however, the development in the construction of paddle-wheels and of the engines designed for paddle-boats may be noticed.

The ordinary paddle-wheel had the floats fixed upon the radial arms, but it was soon found that an improvement could be made by causing the floats to assume a position vertical, or nearly so, at the moment of contact with the surface of the water, and to retain that position until the float had left the water. To effect this the floats are not bolted to the arms but pivoted, and are retained in the required position by means of levers operated by an eccentric pin. By this means a much greater propulsive force was exerted. The old style of paddle-wheel with fixed floats is now very seldom employed. These wheels are now only to be found in vessels in which the expense of construction has to be cut down to a

minimum, or in a certain type of steamer plying in shallow rivers, where the wheel is rather large, and the dip of the float slight; but here again economy of construction may count for more with the proprietor of the boat than the increased speed he could obtain with the more expensive feathering wheels. Many of the modern wheeled vessels have floats of steel, but in the great majority of cases wood is employed, elm being largely used for this purpose. The floats are usually about four times as long as they are broad. Various forms are used, some being left square at the corners, others are rounded, others again have the outer edge elliptical in shape, and the experiment has also been tried with a fair measure of success of inclining the floats to the axis of the wheel, instead of having them parallel to it. The advantages claimed for this last method are that the stream of water formed by the rotatory motion of the paddles is driven slightly away from the sides of the vessel, instead of in a direction parallel with her length. Wheels of this type, however, lose much of their effectiveness when the engines are reversed. Radial wheels are sometimes made with the floats adjusted so that they enter the water almost perpendicularly, but they are much more oblique under this arrangement when leaving the water.

A difficulty which paddle-vessels have to contend with is that of securing a proper immersion of the floats. For a vessel in smooth water the immersion of the top edge is usually calculated at about one-eighth of the breadth of the float; but for a vessel intended for general sea service, an immersion of not less than half the breadth of the float is allowed, that is to say, the float at its moment of deepest immersion has a height of water above it equal to half its diameter. If the float goes much deeper the efficiency of the wheel becomes impaired. This is a point which has to be taken into consideration in designing paddle-boats, so that the maximum power shall be avail-

able when the vessel is fully laden, and shall not be much lessened when the vessel is running light. The earliest steamers suffered greatly in this respect as their designers had not discovered the right size of wheels or floats to suit the hulls. A loaded vessel consequently went very slowly owing to the great depth to which her floats were immersed. To overcome this difficulty an ingenious system of what can best be called reefing was invented. Affixed to the axle of the wheel was a rod with an arrangement of cogs at the end, and these fitted into a series of teeth in rods affixed to the floats, so that it was a simple matter to expand or contract the effective diameter of the wheel by altering the position of the floats as required. The same result has sometimes been obtained by a system of levers, but the toothed wheel business was the older. It was tried on a few of the earlier boats on the Clyde, not always, however, with success.

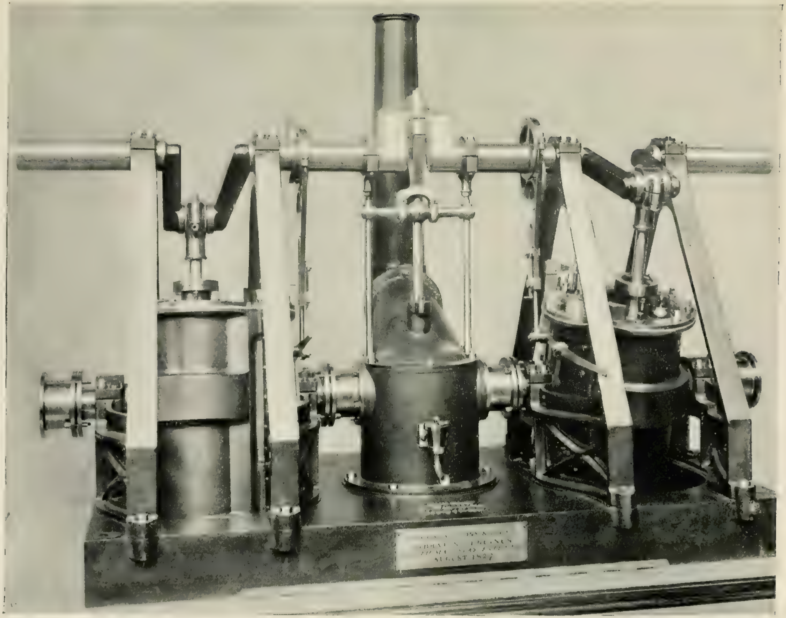
A peculiarity of some of the larger paddle-wheels in use in America is that they are not only of much greater size than those in use in Great Britain in proportion to the size of the boat, but they have a proportionately less immersion and the wheel is constructed in a very different fashion. The floats, instead of being of one piece, as here, are constructed of three narrow fixed strips, two of which are on the same radius but have a space between them equal to the breadth of the third strip, which is placed a few inches behind the vacant space. It is contended that this method disturbs the water less than the broad float and increases the propelling efficiency. Probably the most notable instance is the great wheel of the *Sprague.*

Referring now to the construction of the engines of the earliest boats, Symington's *Charlotte Dundas* used a horizontal direct-acting engine, and the general arrangement of her machinery would be considered creditable even at the present day.* The engine of the *Savannah*

* Sennet and Oram's "The Marine Steam-Engine," 1898.

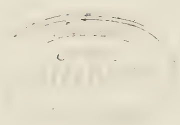
was of the inclined direct-acting type. The type of engine which Newcomen invented has been retained for many years, but the oscillating or walking beam which is such a conspicuous feature of nearly all the American river craft has been placed by engineers in this country below the crank axle instead of above. The type of engine with the beam below the crank axle is known as the side lever. It is a type peculiarly suitable to paddle-wheels, and this being the only method of propulsion adopted on this side of the Atlantic for many years, there was little change for a considerable period in the shape of the engines, which therefore attained to a high stage of perfection until the limit of their profitable employment was reached. When larger engines became necessary, in consequence of the rapidly increasing size of vessels, the great weight of the side-lever engines proved a serious drawback.

Engineers were not long in devising a more compact form of machinery, and direct-acting engines were introduced, these involving the abandonment of the use of the heavy side levers. As the side-lever engines were made larger it became customary to use two beams, one on each side, and a rod from one end of each of these connected with a cross-piece at the top of the piston-rod. The other ends of the double beam were united by a cross-piece which carried from its centre the rod or lever which worked the crank of the paddle-shaft. Where it became necessary to use two engines in one vessel, they were so arranged that while one rod and crank were at their period of least activity, the other pair were exerting their greatest effort. The system of condensation of steam, which it would take too much space to describe in detail, is also a matter of great importance in determining the power of the engine, but the principle upon which the condensation is effected is well known, and the various methods of condensation can easily be ascertained from the numerous handbooks on engineering.



MAUDSLAY'S OSCILLATING ENGINE.

p. 200



Another early form of marine engine was that in which the side levers were arranged as levers of the third order, the fulcrum being at one end and the steam cylinder placed between it and the connecting-rod. The peculiar motion thereby given to the machinery caused this type to be known as the grasshopper engine, from a fancied resemblance to the long legs of a grasshopper. The direct-acting engines were much more compact, more powerful, and lighter than the old side levers. The necessity of providing a connecting-rod of sufficient length was met by Messrs. Maudslay by the provision of two cylinders. The cross-head was not unlike the letter T, the foot of which passed down between the cylinders, and the lower end of this was fitted with a journal from which the connecting-rod extended to the crank in the axle. A still further improvement was made when the oscillating engines were invented, which form an even more compact and simple type. Messrs. Maudslay fitted a pair of oscillating engines in 1828 into the paddle-steamer *Endeavour*, and subsequently into several ships. This form of engine was improved upon by Mr. John Penn, the famous engineer at Blackwall, and the perfection which he gave it has not been surpassed.

The great feature of this method is that the trunnions are hollow, and the steam is admitted to and exhausted from the cylinders through them. The connecting-rod is dispensed with and the upper end of the piston-rod acts directly on the crank pin. This type of engine is the most economical for space and weight that has yet been provided for paddle-wheel engines, the majority of which of late years have been made on this system.

Its adaptability for certain classes of work has given the paddle-wheel a long lease of life. Paddles are peculiarly suitable for certain conditions, such as smooth waters and shallow rivers, where speed and light draught combined with considerable carrying power are essential.

The Indian rivers, for instance, early demanded suitable steamers, and the paddle-steamers *Lord W. Bentinck*, *Thames*, *Megna*, and *Jumna* were built of iron in 1832 for the East India Company for the navigation of the Ganges. They were designed and constructed by Maudslay, Sons, and Field, and fitted with oscillating cylinder engines of 30 nominal horse-power. They were flat-bottomed and were shipped to India in pieces. They were 120 feet in length, 22 feet beam, and had a draught of 2 feet. Their tonnage was 275, builders' measurement.

The steamers sent to India, however, from over sea were not the only ones in that country.

As far back as 1820 there was launched at Bombay the first steamer built in India; she was intended for service on the River Indus. Her engines were designed by a Parsee. She must have been a familiar object to many hundreds of Anglo-Indians during her long career. She was only broken up as recently as 1880, and her end came not through weakness but through her supersession by more modern and commodious boats.

There is a custom peculiar to Bombay, and stated to be of Parsee origin,* of driving a silver spike into the stern of a vessel at its launch. This is said to be analogous to the placing of coins under the foundation-stone. The ceremony was observed at the launching of a paddle-steamer at Bombay in 1875, when a nail some seven inches in length and three-quarters of an inch in diameter was used, but whether such a ceremony took place at the launch in 1820 is not recorded. If it is a Parsee ceremony, however, it is quite likely to have been observed, for the East clings faithfully to its traditions.

A paddle-wheel steamer built in 1859 for service on the Indus had a draught of only 20 inches. The hull was a frameless cellular raft, but the walls of the deck cabin were worked into the depth of the vessel, which

* *Notes and Queries.*

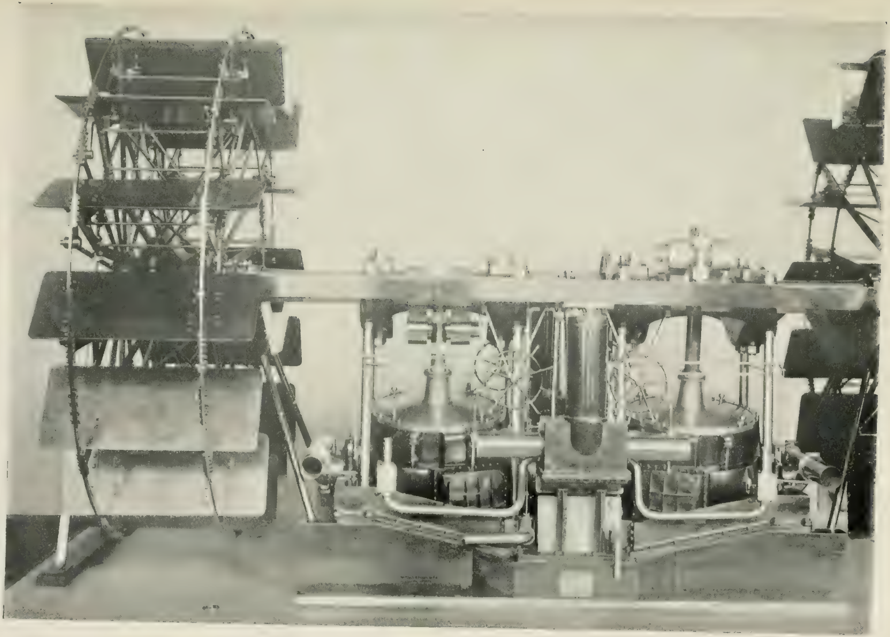
was thus made a girder 200 feet in length, and by this contrivance the engine and boilers, weighing 150 tons, were supported. A couple of plate girders having a run of 115 feet were included in her middle length. These were 15 feet deep and formed the sides of the cabins, and they also projected under the deck for a distance of 35 feet. The hull of the vessel was practically a long, flat, shallow box ; the stern was rounded and the keel was turned up about 2 feet to allow of the water rising easily. The bow was rather fine and designed on the wave-line principle. The engines were of 688 horse-power and the boilers had a pressure of 25 lb. The paddle-wheels were $14\frac{1}{4}$ feet in diameter. Her load displacement was 331 tons and her draught when laden was only 24 inches.

The *Ly-ee-moon*, launched in 1860 by the Thames Iron and Shipbuilding Company, resembled in some respects the steam-yacht of the Queen. She was built for Messrs. Dent and Co. for service between Hong-Kong and Shanghai, and was 270 feet in length and 27 feet 3 inches beam with a draught of 12 feet 6 inches. She was of 1003 tons register and 1394 tons displacement; her oscillating engines had cylinders of 70 inches diameter, with a stroke of $5\frac{1}{2}$ feet. She was the first merchant vessel fitted with Lindsay's apparatus for scaling the boilers with superheated steam. The paddles were 22 feet diameter. She had two masts, the foremast carrying lower yard, topsail yard and topgallant yard, and the trysails reached to the topmast head and gave her a good spread of canvas. She also carried several guns, and the sponsons were so fitted that the guns could be worked on them in case of need. Her speed was from 18 to 19 miles an hour. She afterwards passed into the possession of the Japanese ; the story goes that when she was making her first run with Japanese only on board, the Japanese engineers, being unable to stop the engines, put the helm hard over and sat down to wait with true Oriental patience until the steam gave out

and she stopped of her own accord. The *Ly-ee-moon* afterwards passed into Australian ownership and she ran for a long time in the excursion and coastal trade, and was finally wrecked in March 1886, when seventy persons lost their lives.

The paddle-steamer *Leinster* was one of four constructed of iron for the mail service between Holyhead and Kingstown in 1860 by Samuda Bros. She had nine water-tight bulkheads. A vessel intended for this service, on which exceedingly rough weather is at times encountered, through which the vessels are driven at full speed in order to ensure the punctual delivery of the mails, has to be built very strongly to stand the strain of the rough seas. For this purpose the paddle-boxes were formed of iron plates internally, continued from the sides and bulwarks of the vessel together with a strong girder extending from each bow. Two of the four, the *Ulster* and *Munster*, were withdrawn from the service in 1896–7 and turned into barquentines, their places being taken by larger vessels of the same names. The present bearers of the names are twin-screws and have triple-expansion engines. The engines of the former boats had each two oscillating cylinders, 98 inches in diameter and having a stroke of 78 inches, situated immediately below the paddle-shaft. They had each eight multitubular boilers bearing steam at 20 lb. pressure, arranged in pairs, four before and four abaft the engines, and with their ends backed to the sides of the vessel so as to allow of the stoking of the furnaces from a middle gangway. The paddle-wheels, 32 feet diameter, had fourteen floats 12 feet in length by 5 feet in width. The indicated horse-power was 4751, and the average speed in all weathers was 15½ knots.

Messrs. Scott, Russell and Co. launched at Millwall in September 1854, for a Sydney company, the steamer *Pacific*, which was expected to prove one of the fastest vessels afloat. She was 270 feet in length over all, breadth 32 feet, depth 34 feet, and tonnage 1200. She had

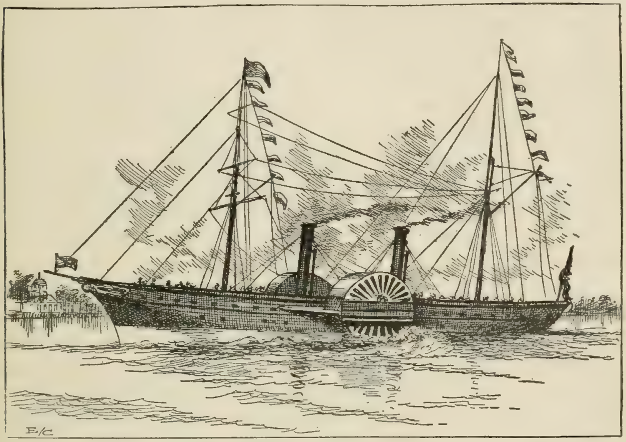


MODEL OF THE ENGINES OF THE "LEINSTER."

p. 204

oscillating engines of 450 horse-power nominal and over 1000 effective, four independent boilers, and her feathering paddle-wheels were of exceptional strength. She was estimated to steam sixteen miles an hour.

There was launched in the beginning of 1861 by Messrs. Pearse and Co. of Stockton-on-Tees, for the conveyance of troops on the lower Indus, a vessel which



THE "PACIFIC."

fulfilled the rather unusual requirements of a Government Commission appointed to discover the best means of navigating the Indian rivers which, though broad, are often shallow in places, and abounding in sandbanks. This vessel was 377 feet over all, beam 46 feet, breadth over paddle-boxes 74 feet, depth 5 feet, with a displacement at 2 feet draught of 730 tons. Her tonnage was 3991 under the old system of measurement. Her engines, by Messrs. James Watt and Co., were of 220 nominal horse-power, with horizontal cylinders of 55 inches diameter

and 6 feet stroke. The paddle-wheels were 26 feet in diameter. The hull was of steel strengthened longitudinally by four arched girders, two of which carried the paddle-wheels, and the other two extended nearly the full length of the ship. Other girders strengthened her athwartships. She had no rudders in the ordinary sense, but was steered at each end by blades, which were raised from or lowered into the water at the required angle. The vessel had two tiers of cabins, and could accommodate 800 troops and their officers.

The paddle-steamer *Athole*, built by Messrs. Barclay, Curle and Co., Ltd., in the year 1866, was the first steamer to be fitted with the saloon above the upper deck. The credit for this improvement rests entirely with the late Mr. John Ferguson, who was then manager of the ship-building yard. So impressed were Lloyd's that they desired Mr. Ferguson to patent his improvement, but this he refused to do as he considered it ought to be given to the shipbuilding world free of royalty.

Messrs. A. and J. Inglis were the builders in 1882 of the steel paddle-steamer *Ho-nam*, which has the distinction of being one of the few, and probably the first, English-built vessels constructed on the American plan. She was rigged as a two-master carrying fore and aft sails only. Her paddles were placed very far aft, and she was fitted with a walking beam-engine. She was constructed for the Chinese coastal trade and was of 2364 tons gross register, and was so successful that others of the same type followed.

These necessarily brief notices of some of the more remarkable paddle-boats of modern times, together with references in other chapters to paddle-steamers of still more recent years, are sufficient to show that the earlier form of propulsion has never been entirely superseded by the screw.

Possibly the earliest definite attempt to apply the screw for propelling purposes was made by David Bushnell in his abortive submarine exploit, an account of which appears

in Chapter XII. hereafter; * but the propeller seems to have been very primitive. The screw propeller was also proposed in 1752 by the mathematician Daniel Bernoulli. A patent was granted in 1794 to William Lyttleton for a screw propeller which was caused to revolve by an endless rope passing round a wheel at the end of the axle. It was a distinct attempt to solve the problem and nearly succeeded, but it failed because there was too much of it. Had he been contented to use one pair of blades he would have obtained better results than by using two pairs of wide blades and two odd blades, arranged with three blades on either side of the axle so that his propeller became really a long spiral wheel. He also failed from the lack of sufficient power to drive the wheel, as manual labour only was used. Still, a boat fitted with this screw was tried at the Greenwich Dock, London, and a speed of two miles an hour was stated to have been obtained.

In 1800 Mr. Shorter, master of the transport *Doncaster*, brought out two plans of propulsion. One was in the form of two duck-foot paddles with an alternate movement; the other was a two-bladed screw propeller. The latter was attached to an inclined shaft carried by a universal joint to the deck of the vessel. One of these methods was said to have moved the *Doncaster* at a speed of about a mile and a half an hour, the contrivance being driven by eight men running round a capstan. It is difficult to believe from the picture which accompanies his plan, dated 1800, that a transport of the size depicted could have been moved at half that speed with the apparatus shown, although the fact that it was mechanically propelled is attested by credible witnesses.

The first really successful screw-propelled boats were those of Colonel John Stevens, which were in operation on the Hudson River from the years 1802 to 1806, and were the first to be used for the effective navigation of the

* See p. 376.

waters of any country. References have already been made to Stevens' experiment with paddle propulsion in 1796. When he, Chancellor Livingston, Nicholas J. Roosevelt, and Isambard Brunel were making experiments in steam propulsion on the Passaic River, New Jersey, they tried a horizontal centrifugal wheel in a boat of 30 tons, drawing water from the bottom of the boat and discharging it at the stern. This is in its general principles similar to the plan that Mr. Ruthven tried in England on the *Waterwitch* more than half a century afterwards. They also, unsuccessfully, attempted to use elliptical paddle-wheels.

Probably the best description of Colonel Stevens' propeller is that which he himself contributed to the *Medical and Philosophical Journal* of New York in January 1812. He refers to the "mischievous effects necessarily resulting from the alternating stroke of the engine of the ordinary construction" which induced him to turn his attention to the rotary principle of steam-engine construction. "For simplicity, lightness, and compactness the engine far exceeded any I have yet seen. A cylinder of brass, about eight inches in diameter and four inches long, was placed horizontally on the bottom of the boat: and by the alternate pressure of the steam on two sliding wings, an axis passing through its centre was made to revolve. On one end of this axis, which passed through the stern of the boat, wings like those on the arms of a windmill were fixed, adjusted to the most advantageous angle for operating on the water. This constituted the whole of the machinery. Working with the elasticity of the steam merely, no condenser, no air-pump was necessary; and as there were no valves, no apparatus was required for opening and shutting them. This simple little steam-engine was, in the summer of 1802, placed on board a flat-bottomed boat I had built for the purpose. This boat was 25 feet long, and about 5 or 6 feet wide. She

STEVENS' 1804 ENGINE, FITTED INTO OPEN BOAT WITH TWIN-SCREW PROPELLERS

p. 208

was occasionally kept going until the cold weather stopped us. When the engine was in the best order, her velocity was about four miles an hour. I found it, however, impracticable, on so contracted a scale, to preserve due tightness in the packing of the wings in the cylinder for any length of time. This defect determined me to revert again to the reciprocating engine."

Stevens and his son were crossing the Hudson in this boat on one occasion when the boiler, which was constructed of small tubes, gave way, and the next boiler was constructed with the tubes placed vertically. The engine was kept going for a fortnight or three weeks in the latter part of the summer of 1804, the boat making excursions for two or three miles up and down the river, and for a short distance he could get a speed out of it of seven or eight miles an hour.

Stevens' early experiments with the screw propeller taught him that a vessel driven by only one screw has a tendency to move in a circle. This tendency is displayed in single-screw vessels to the present day. As is well known, a vessel driven by a right-handed screw will deflect slightly to the left, and a vessel driven by a left-handed screw will have a tendency to turn to the right. The explanation given of this peculiarity in the Stevens' boat by Dr. P. Jones, who was superintendent of the United States Patent Office up to the date of its reorganisation under the law of 1836, in the *Journal of the Franklin Institute* for 1838, is that this tendency was due to the lessened resistance, as the vanes of the propeller rose towards the surface, in consequence of the greater ease with which the water was removed out of the way. Consequently Stevens overcame this difficulty by using two such wheels placed side by side and revolving in reverse directions.

The original screw-engine is still in existence in the Museum of the Stevens Institute at Hoboken, New

Jersey. The original boat, of course, has long since disappeared. A replica of it was tried with the old engine on the Hudson in October 1844, and attained a speed of eight miles an hour.

One great difficulty which early steamers had to contend with was that of boiler pressure. It should be remembered that the five distinct means Stevens proposed in connection with his screw propeller were:

1. The short four-bladed screw propeller.
2. The use of steam of high pressure.
3. The multitubular boiler.
4. The quick-moving engine connected directly to the propeller shaft.
5. Twin screws.

Not one of these means was applied to steam-ships until about forty years later, but all have contributed since their adoption to the success of the ocean navigation of the present day.

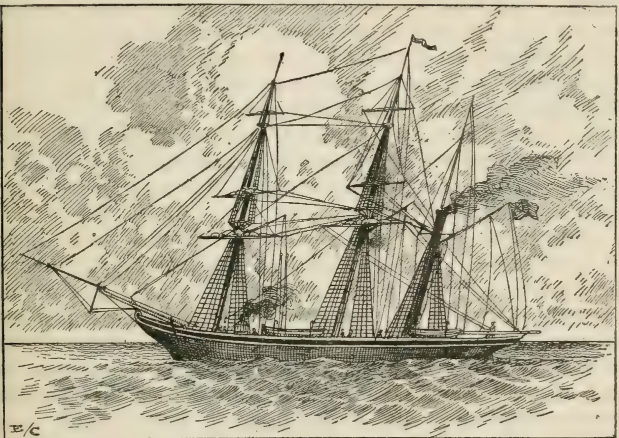
Stevens' plan for working twin screws by a single cylinder is the most simple that could be devised. When the screw propeller came into use this plan was revived both in America and in Europe, and was known in France as the "Etoile" engine.

The principal reason for Stevens' failure with the screw propeller was that there were no tools or competent workmen in America to construct properly the steam-engines that he planned between 1800 and 1806, and success was therefore impossible. He therefore reverted to the paddle-wheel with its slow-moving engine and the boilers then in use, carrying steam at a pressure of two or three pounds above the atmosphere. Stevens was not disposed to abandon the screw entirely, for he presented a plan in 1816 to the United States Government for a warship propelled by that means, but nothing came of it.

In the spring of 1825 an advertisement appeared in the *Times* offering a hundred guineas for a means of

propelling vessels without paddles, and in that year a company was formed for applying the gas vacuum engine to canal navigation.

Some of the earlier steam-engine-propelled iron vessels were strange craft. Designers and builders felt that they were entering upon new ground, and being less trammelled



THE "Q.E.D."

by tradition allowed their fancy free play. Their plans were occasionally daring in their originality and came astonishingly near to achieving success.

A freakish-looking vessel was launched on July 15, 1844, from the yard of her owner and builder, Mr. Cootes, at Walker-on-Tyne. She was a collier, built of iron, and carried a screw propeller driven by a small engine. On this account she is said to have been the first iron screw collier, antedating by some years the *John Bowes*, to which the honour is usually given. This ship was confessedly an experiment and was named the *Q.E.D.*,

and as her name was not changed during her career she no doubt gave satisfaction. The sea-borne coal trade was largely confined to wooden brigs of comparatively small tonnage. The *Q.E.D.* was barque-rigged, "with taut masts and square yards, the masts raking aft in a manner that is seldom seen except in the waters of the United States. She was provided with a 20-horse-power engine by Hawthorn, which turned a propeller (screw), a compound of several inventions, having four flies or flaps at right angles with each other, the bend of each flap at an angle of 45 degrees from the centre."

On her first voyage to London,* when she had about twenty keels of coal on board, she grounded on the Gunfleet Sands, but was refloated undamaged after some of her cargo had been thrown overboard.

Constructionally she presented several very novel features, which embodied the iron shipbuilding science of the time. Her over-all length was 150 feet, beam 27 feet 6 inches, and with the 340 tons of coal on board she was constructed to carry, she drew 11 feet 9 inches aft and 10 feet 3 inches forward. She is said to have been the first water-ballast vessel, for her hold was divided into separate chambers and each chamber had a false floor, between which and the hull was the space for water-ballast. The water, which was her only ballast, was admitted through taps and was pumped out by her engine. This was just a small steam auxiliary, capable of giving her a speed of four knots in a calm. Her mizzen-mast was of iron and hollow and was used as a funnel for the engine fires, so that when her furnace was going her mizzen rigging appeared to be on fire. Her bows had a

* Mr. Charles Mitchell, afterwards head of the shipbuilding firm which amalgamated with Sir W. G. Armstrong and Co. under the style of Armstrong, Mitchell and Co., Ltd., went to sea in this vessel for one or two voyages, to watch the behaviour of her engines.—"The Making of the River Tyne," by L. W. Johnson.

sharp wedge-shape with considerable sheer, her stern overhung to an unusual degree, and her counters were very flat so as to lift her stern to the sea. The stern bore an armorial bearing with the motto "Spes mea Christus," and "*Q.E.D* of Newcastle." The cabin was commodious, with a raised roof surrounded with window lights, and had four sleeping compartments, with a stateroom for the captain. A swinging compass was suspended, having a magnet on each side, and one before it, to counteract the attraction of the iron. Her shrouds were of wire rope served over with a strong double screw to each, a method in use to the present time. The main-mast from step to cap was 65 feet, the main yard 52 feet, and the mast, from the keel to the royal truck, was 130 feet.

As she steered with ease, sailed well, and exceeded expectations with the screw propeller, confidence was expressed "that the time is not far distant when our ships of the line will be fitted with engines and screws in a somewhat similar manner." Four years after her launch her engines were removed and she was rigged as a barquentine. She ultimately went to the bottom of the English Channel in 1856.

As a steam collier the *Q.E.D.* can scarcely have been a success or her engines would not have been taken out of her. Probably the first real steamer to which the title can be applied was the *John Bowes*, built at Messrs. Palmer's yard, formerly in the possession of Mr. Cootes. Messrs. Palmer Brothers and Co. established the fifth yard on the Tyne for iron shipbuilding purposes and the *John Bowes* was their first vessel. Two steam colliers of a sort had already been built on the Mersey, but they were little better than steam barges. This, the first seagoing steam collier with a screw propeller, was 167 feet over all, 25 feet 7 inches beam, 15 feet 6 inches depth, and of 270 tons register. The firm started in 1851, and about this period the working of the new Midland coalfields began seriously

to affect the sale of north country coal, which had hitherto been conveyed to London in small collier brigs. It now became imperative in the interests of colliery owners to devise some means by which the staple produce of the district could be conveyed to the metropolis expeditiously and regularly. Sir (then Mr.) Charles Palmer, who was connected with several large collieries in Northumberland and Durham, therefore designed the *John Bowes* with a carrying capacity of 650 tons, and capable of steaming nine miles an hour. She was launched on June 30, 1852. The experiment proved a complete success, and to it may be attributed the important development of iron shipbuilding on the north-east coast which afterwards took place. The *John Bowes* was the forerunner of a long list of screw colliers, and was speedily followed by the *William Hutt*, the *Countess of Strathmore*, and numerous vessels of a similar type.

Captain Blackett, R.N., speaking at the launch of the *John Bowes*, expressed the opinion that paddle-wheel ships were doomed altogether. The chairman, Mr. Charles M. Palmer, referred to the superiority of the vessel over the sailing brigs, and added: " The application of iron to shipbuilding, especially to colliers, gives great advantages. There being much more space than is required for cargo, the surplus in the *John Bowes* is available for water-ballast, by placing an inner bottom, with compartments, thus saving much detention and expense, the water being pumped out by the engine used for the screw propeller. When this description of collier is brought into general use, and the coal merchants can be supplied with regularity, and, moreover, cannot take advantage of the fleets, they will no doubt purchase from the coalowners at a price on board in the north, and thus obviate the ruinous speculations now existing, and present the most effectual mode of regulating the trade. I am aware that in substituting iron screw steamers for wooden sailing vessels we are

THE "JOHN BOWES." LAUNCHED 1852.

THE "JOHN BOWES," 1906
(PASSING PALMER'S SHIPYARD, WHERE SHE WAS LAUNCHED, 1852).

p. 214

running counter to the wishes of many shipowners, but I am satisfied we are taking the right course; we have the public with us: and I am confident of success." His confidence is justified by the history of the Tyne.

Numerous attempts were made to solve the problem of the proper application of the screw propeller. Most of them were fantastic and a few were even absurd. The difficulties that inventors had to surmount were so great that it is no wonder many gave up the struggle in despair, notwithstanding the obvious advantages of this method. They had to decide where the propeller should be placed so as to give the best results, without interfering with the steering powers of the rudder. They had to ascertain the best material for the bearings of the propeller shaft in order to avoid the wearing away or the overheating of the shaft and bearings through the friction caused by its revolutions; for worn bearings meant leakage and excessive vibration, and the latter meant an ever-increasing strain on the structure of the ship, this being particularly the case with wooden vessels.

By degrees these obstacles were overcome, but the questions of the number, size, and shape of the blades, their pitch, or theoretical forward movement in making a complete turn, their degree of immersion and their most efficacious speed, are taxing the brains of the most skilled naval engineers and architects of the present day. Obviously, these questions are of the highest importance to all students of marine engineering no less than to steam-ship owners. As the power of the engines increased other considerations had to receive attention, including the best material for the construction of the propeller and the best methods of building or casting it to stand the enormous strains imposed upon it by the work it had to perform.

Almost simultaneously John Ericsson, the famous Swedish inventor, and Francis Pettit Smith, a Middlesex farmer, were engaged in experiments. Mr. (afterwards

Sir) F. P. Smith made, in 1836, a clockwork model of a boat with a screw propeller, and it was so successful that he built a steam launch in order to try the experiment on a larger scale. This boat, the *F. P. Smith*, was about 29 feet long and 5 feet 9 inches beam, and was tried in the Paddington Canal in 1837; its power was derived from a steam-engine with a cylinder having a diameter of 6 inches and a stroke of 15 inches. The propeller was of wood with two full turns, and was placed some distance in front of the sternpost, where it was driven by a system of bevel wheels from the engine to the shaft. The propeller lost a blade on one of its trips, thereby adding to the speed of the vessel, and this led Mr. Smith to instal another screw with one turn only, or a half-turn on each blade. A metal propeller was afterwards substituted, and the boat went from London to Folkestone and other places on the coast at an average speed of five to five and a half knots.

It is stated Mr. Smith built a vessel of 60 tons* which, with a screw propeller, attained a speed of seven or eight miles an hour and went from Blackwall to Margate in eight and a half hours, and that she also towed the *British Queen* steamer into the West India Dock. This probably refers to the *F. P. Smith*, the assertion that she was of 60 tons being erroneous. The results of the experiment were so satisfactory that a syndicate was formed which took the matter up and brought out the Ship Propeller Company, to whose capital Messrs. Rennie, the shipbuilders, subscribed £2000.

This syndicate built the steam-ship *Archimedes*, the first seagoing vessel driven by a screw propeller. She was of 232 tons, and had engines of 80 horse-power. The cylinders were 37 inches in diameter and of 3 feet stroke, and the screw, being geared in the proportion of a fraction over five to one, made 140 revolutions per minute to about 27 revolutions of the engine shaft. The screw

* *Historic Times*, March 1849.

was formed of plates of iron fastened to arms of wrought iron, keyed upon a wrought-iron shaft. The boiler was suited to the shape of the vessel. The engines, chimney, boiler, coal-boxes, driving machinery, and propeller weighed altogether rather more than 64 tons. The propeller was fitted in such a way that it could be brought on deck for repair or when not required for use. The ship was 125 feet over all and $22\frac{1}{2}$ feet beam. Various types of propeller blades were tried with her, and she was also sent on a voyage round the ports of Great Britain to demonstrate the effectiveness of this method of propulsion. On this trip she called at Bristol, where the *Great Britain* was under construction, and was thus the cause of the screw propeller being adopted for that ship.

One of the tests to which the *Archimedes* was subjected was a voyage between Dover and Calais in the company of two of the Post Office packets, which she beat handsomely. She went from London to Portsmouth in 1839, and continuing her voyage round the ports of the British Islands, to provide ocular proof to all interested, put in at Plymouth, where she was boarded by Admiral Sir Grayham Moore and the Commander-in-Chief, who were then convinced of the usefulness of the screw.

The next year the *Novelty* was built for the owners of the *Archimedes* by Mr. Wimshurst at Blackwall, to demonstrate still further the seagoing merits of a screw-propelled vessel. Her two-bladed screw was placed as near the sternpost as possible, and one of its features was that it had only a quarter of a turn to the blade. Her boilers worked at a steam pressure of sixty pounds above that of the atmosphere, the highest then attempted, and up to then regarded as impossible for a steamer. She took a general cargo to Constantinople, to which port she was the first screw cargo boat to go; but as on her return objections were raised that the pressure was too high, other engines were substituted working at only a quarter of the

pressure. She was one of the few vessels in which the mast was used as a funnel, her mizzen-mast being made hollow and of iron for the purpose: she is also said to have been the first vessel to be fitted with an iron mast.

John Ericsson in 1836 patented a propeller consisting of two drums from which projected seven helical blades connected by an external hoop. The blades were inclined in opposite directions, thus forming a double screw propeller, the propellers being placed immediately behind the rudder, which had the usual " shark's mouth " to allow of steering. The shafts were made so that one passed through the other, the outer one being tubular. The drums revolved in opposite directions, that nearer the sternpost moving at a slightly faster rate than the after drum. This method of arranging the propellers was adopted with a view to avoiding the loss caused by the motion imparted to the water by the single screw, but it was found that the trouble caused by the contrivance was not worth the results obtained. Another drawback was that the extra friction induced by one shaft operating within the other was so great that the contrivance was practically useless where a high speed was desired. The steamer *Francis B. Ogden* was tried with this type of propeller in 1837, and towed the American sailing ship *Toronto*, of 630 tons burden, on the Thames at the rate of five miles an hour. The *Francis B. Ogden* was about double the tonnage and power of Smith's boat, being 45 feet long and having a high-pressure two-cylinder engine giving the propellers about 30 revolutions per minute. Ericsson's next experiment was with the *Robert F. Stockton*, which was built by Laird at Birkenhead in 1838. She was 63 feet long and of 33 tons, and had engines of 30 horse-power. Prior to this his screw boat towed the Admiralty barge with my Lords of the Admiralty on board on the Thames, but the effort to convince them of the practicability of the method was doomed to failure,

Model of the "Novelty." Built 1839.

p. 218

since they had previously decided that as the power was applied at the stern the vessel would not steer.

The *Robert F. Stockton* crossed the Atlantic under canvas in 1839, and after one of the screws had been removed as useless, she was employed for a quarter of a century as a single-screw tugboat on the Delaware, under the name of the *New Jersey*. Commodore Robert F. Stockton in that year induced Ericsson to resign his office in London as superintending engineer of the Eastern Counties Railway and go to the United States. Several vessels were fitted with his propellers for river and inland waters navigation in America.

Mr. Ogden, who was American Consul at Liverpool from 1829 to 1840, and at Bristol from 1840 to 1857, "is credited with having first applied the important principles of the expansive power of steam and with the employment of right-angular cranks in marine engines. In 1813 he received a patent for low-pressure engines with two cylinders, working expansively, and the cranks being adjusted at right angles, and in 1817 the first engine ever constructed on this principle was built by him in Leeds, Yorkshire. He submitted his plan to James Watt, at Soho, who declared at once that it was a beautiful engine and that the combination was certainly original." *

The definite adoption of the screw propeller, both for the Royal Navy and the Mercantile Marine, may be said to have taken place in 1840–41. For some years no bearings of brass or other metal could be got to stand the strain of the stern shaft, "and at one moment it seemed as if the screw must be abandoned and the paddle-wheel reverted to. Mr. Penn solved the problem by using lignum-vitæ wood bearings, which, lubricated by water, were found to act without any appreciable wear, and in this simple way the screw has already been able to reach a point of development from which we can now calmly look back

* Appleton's "Cyclopædia of American Biography."

upon the financial risks and terrors which beset the early days of steam navigation."*

The difficulty of steering screw-propelled vessels was considerable, principally owing to the method of placing the screw in an aperture in the deadwood, while at the same time retaining the full underbody aft. The full power of the screw could not thus be exerted, and the attendant churning of the water interfered with the steering power of the rudder. A system of double rudders was brought out in an attempt to solve the difficulty, but the disadvantages it possessed were against its general adoption. These rudders were hung respectively one on each side of the forepart of a somewhat extended sternpost, against which they lay when amidships, moving out as required to steer the ship, or both could be moved outwards to help to stop her. The sternpost was really a vertical hollow box through which the screw framing passed, the screw working behind it and beyond the rudders. Later improvements in shipbuilding rendered this device unnecessary.

The difficulty was solved by the simple expedient of placing the sternpost farther aft so as to give room for a greater space in the deadwood in which the propeller was to act.

The superiority of the screw to paddles was now being gradually admitted, and the number of small vessels fitted with screws increased. But no one had as yet dared to launch a large screw steamer for ocean voyages.

The honour of being the first to do this was gained by the Great Western Steamship Company. The *Great Western*, which has been mentioned in Chapter V, had been so successful that her owners felt justified not only in ordering another vessel but in determining that their new steamer should be the largest afloat and illustrate the latest theories of construction. There

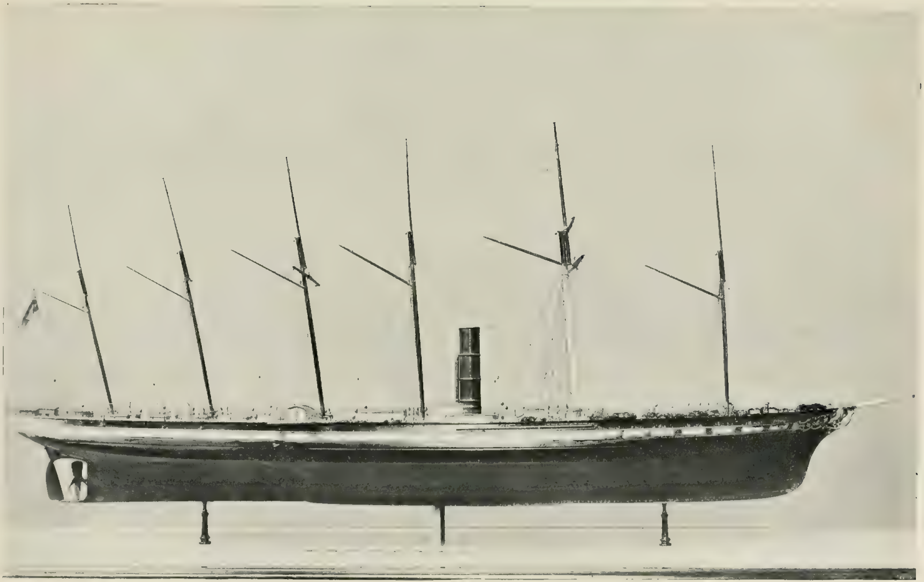
* *The Times.*

were already rumours of competition in the North Atlantic trade, and the Great Western directors did not intend to be forestalled. They decided to build an iron ship and it was accordingly announced that the *Great Western* was to be followed by the *Great Britain*, of iron. This project was roundly condemned by the public. The fact that iron steamers were already in existence on Irish waters did not count for much. These might be good enough for Irish lakes and rivers but would be unfit for the Atlantic Ocean. The *Garry Owen* was already forgotten.

The Great Western Company, however, persisted. The *Great Britain* was designed by the younger Brunel and launched in 1843. Her length of keel was 289 feet, and length from figure-head to taffrail 320 feet. Her beam was 51 feet. The total depth from the under side of the upper deck to the keel was 31 feet 4 inches. Her tonnage was 3500 tons and her displacement at 16 feet was 2000 tons. Her cargo capacity was 1200 tons measurement, and her coal bunkers held 1000 tons. Since no shipbuilder had the necessary data for the construction of such a vessel, and shipbuilders as a whole were by no means favourably disposed towards iron ships, possibly because they had not the plant necessary for their construction, and as there was also a very widespread belief that a vessel of the size and dimensions of the *Great Britain* could not be built of iron, the directors were unable to find a contractor who would undertake her construction. They were therefore obliged to instal the plant for building the ship and the engines also. She was built under the supervision of Paterson of Bristol, who was responsible for the *Great Western*. It was at first intended that the *Great Britain* should be a paddle-steamer and her lines followed in several respects those of the best paddle-steamers of the day; though the *Great Britain* herself contained so many novel features and was of so experimental a character that it could hardly be said that she followed anything.

Little had been done to demonstrate the power of the screw propeller, which for some unfathomable reason was considered to be suitable only for small vessels. However, after the construction of the *Great Britain* had been commenced, the steamer *Archimedes*, fitted with Smith's screw propeller, arrived at Bristol during her tour of the ports and demonstrated once and for all that the screw propeller could be used in seagoing vessels, and that, provided engines of sufficient power were installed, the screw propeller was more suitable for large hulls built to make ocean voyages than the best paddle-wheels then designed. But many years were to elapse before the shipping industry generally accepted this view.

The advantages of the screw, as proved by the *Archimedes*, were not, however, lost upon the enterprising directors of the Great Western Steamship Company, and they did not hesitate to order the designs of the *Great Britain* to be altered so that she could be fitted with a screw instead of paddles. She was not built on a slip whence she might have been launched into the river, but in an excavated dock, and when she was afloat in the dock it was found that she was too big to be got out of it. That is to say, that having been fitted with her engines while still in dock, their weight immersed her to such an extent that she could not float out. This was owing to the dock officials' delay in finishing alterations to the dock entrance, and not to any mistake or negligence on the part of the steamer officials. She was water-borne on July 19, 1843, and was christened by Prince Albert. The floating was attended by vexatious mishaps. The *Great Britain* was attached by a hawser to the tug *Avon*, which was outside the dock, but at the critical moment the hawser broke. The bottle of wine thrown at the ship by the Prince fell several feet short. He threw another bottle of champagne, which struck the bows, and the wine and broken glass fell upon the men below, who



MODEL OF THE "GREAT BRITAIN."

p. 222

were pushing against her sides to keep her off the dock walls.

Her figure-head consisted of the royal arms, flanked with a beehive, two cog-wheels, a dove, square, and the caduceus of Mercury in bronze on a white ground, with a scroll above and below. Her anchor was on Porter's newly invented patent, which had been satisfactorily tested in the Navy for three years.

Her designer and builder took no chances. She was put together as strongly as possible, and it was well that this was so, for in her eventful career she was altered so frequently and so much that had she not been excellently put together she would very soon have succumbed to ship surgery. Her keel was formed of iron plates varying from three-quarters of an inch thick in the middle to one inch at the ends.

The plates of the hull under water were from three-eighths to half an inch at the top, except the upper plate, which was five-eighths of an inch. She was clincker-built and double riveted throughout. Towards the bow and stern and in the upper strakes the thicknesses were reduced gradually to seven-sixteenths. The ribs were of angle iron six inches by three and a half, by half an inch thick at the bottom of the vessel and seven-sixteenths thick at the top. The boiler platform was of plate iron supported upon ten iron keelsons. The hull was divided into five compartments by water-tight iron bulkheads. The decks were of wood and consisted of the cargo deck, two cabin decks, and the upper deck.

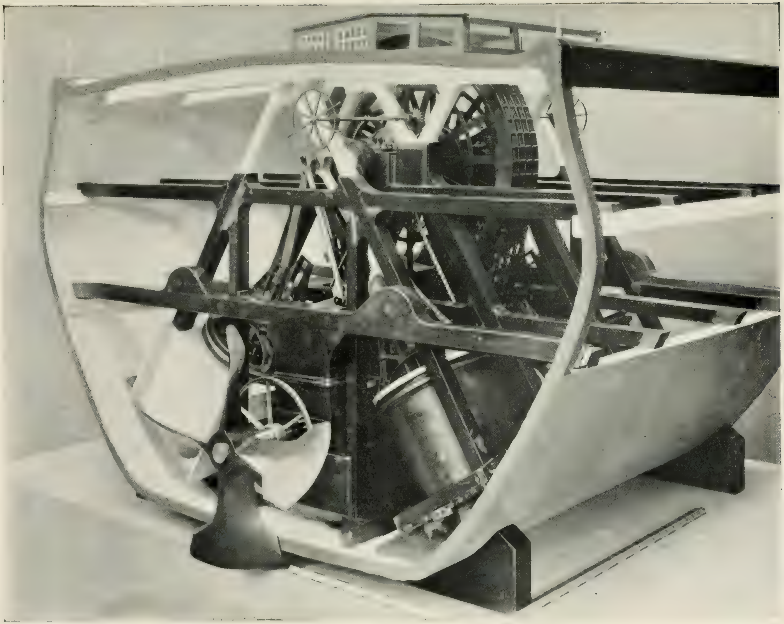
The beams for the support of the decks were bars of angle iron about three inches across with an additional bar measuring five inches by half an inch riveted on the side. The beams were from 2 feet 4 inches to 3 feet apart. There were also between the angle-iron bars and deck planks a series of diagonal flat tension bars, forming a continuous horizontal truss from end to end in each

principal deck ; these bars were riveted to the angle irons at the crossings and at the ends in order to prevent horizontal straining. The engine-room was strengthened by adding nine additional double ribs and sixteen additional reverse ribs riveted to the original framing. Her three boilers were each 33 feet in length, 10 feet wide, and 24 feet high ; she had 24 fires, 12 fore and 12 aft, with a total surface of fire-box of 288 superficial feet. Her chimney was 8 feet in diameter and about 45 feet high ; her four cylinders were 7 feet 4 inches diameter with a piston-stroke of 6 feet. Her two condensers of wrought iron three-quarters of an inch thick were 12 feet in length. The main wrought-iron shaft measured 15 feet 9 inches.

The engines were after Sir Mark Brunel's patent in the position of the cylinders, except that they were disposed at an angle of about 60 degrees. The pitch of the screw was 13 feet 2 inches and its diameter 15 feet. It was six-bladed, and the screw shaft was revolved by four endless chains.

The crew numbered one hundred and thirty all told and she could accommodate three hundred and sixty passengers. Her principal promenade saloon was 110 feet in length by 48 feet at the widest part and 7 feet high, and had two staircases at each end. Her first-class dining-room was 100 feet in length by 50 feet wide and 8 feet high, with staircases communicating with those of the promenade saloon. Seeing how far she excelled all other steam-ships, she well merited being called by the newspapers a "stupendous steam-ship" of "unparalleled vastness."

Her rig was as unique as her hull. She had six masts, of which only the second carried square sails, all the others being fore and aft rigged, and her one funnel was placed between the second and third masts. Five of her masts were stepped on turntables on deck so that they could be



MODEL OF ENGINES OF THE "GREAT BRITAIN."

p. 221

lowered and offer less resistance when going against a head wind. The lines of the ship were very fine, especially about the entrance from the forefoot. There was little of the "cod's head and mackerel tail" style of build about her. She was admitted to be rather full amidships, for the accommodation of the engine, but was thought to approach as near the figure of least resistance as possible. The hull had a slight sheer and the vessel realised the expectation that she would be what sailors call "a dry ship."

After getting out of the dock at last she left for London, where she arrived in January 1845 after a stormy voyage which tested her thoroughly. She remained five months at Blackwall, being visited by the Queen and Prince Albert, and left in June of that year with about eighty passengers for Liverpool, calling at a number of ports *en route*. She left the Mersey for New York on July 26 with from forty-five to sixty passengers (accounts differ) and about 600 tons of cargo. The voyage lasted 14 days 21 hours, and her average speed was nine and a half knots, but the engines were only worked at about 600 horse-power. New York was disappointed with her, as her six low masts contrasted unfavourably with the tall graceful masts of the American ships. She made the return journey in a day less.

On a subsequent voyage she broke one of the blades of her propeller, but as she made between ten and eleven knots, using both propeller and sail, it was decided when she was docked for repairs that her new propeller should have four blades only. In September 1846 she ran on the rocks in Dundrum Bay on the coast of Ireland, and was not refloated until August 1847. Thanks to her strong construction she was able to withstand a winter's storms and a stranding of eleven months.

After being brought to Liverpool, she lay for some time at the North Docks and, as the Great Western Steamship Company thought the repairs would be too

costly, she was purchased by Messrs. Gibbs, Bright and Co., formerly agents for the company, and they decided to refit her. The rolling plates attached to the sides of the hull were removed. An oak keel was bolted through upon the iron plates which had done duty for a keel when she was first built, to prevent rolling. Her bottom for about 150 feet had to be entirely renewed. The bows and stern were strengthened by double angle-iron framing secured by three tiers of iron stringers 2 feet 3 inches wide and five-eighths of an inch thick. Ten new keelsons were placed in the ship running her entire length, half as deep again as those formerly used. The various alterations resulted in the cargo capacity being increased by about 1000 tons, partly through the space saved by new boilers and partly through the construction of a deck-house 300 feet long and 7 feet 6 inches high. New bulwarks were erected higher than the previous ones. The number of masts was now reduced to four.* Two of the lower masts were iron cylinders and the two centre masts were ship-rigged, carrying royals. The fore and jigger were fore and aft rigged, but whereas the topsail of the foremast was shaped like a lugsail that of the jigger was carried on a gaff, according to a contemporary picture. The old engines were of 1000 nominal horse-power, but it is a question if they ever worked over 600 horse-power; the new engines were nominally 500 horse-power. Her new pair of oscillating engines were by John Penn and Son, engineers, Greenwich, and had cylinders 82½ inches diameter and 6 feet stroke. By the use of cog-wheels the screw shaft made three revolutions to one of the engine.

The screw was three-bladed, 15 feet 6 inches diameter,

* According to a description and picture in the *Illustrated London News* she had five masts, the first, fourth, and fifth masts being fore and aft rigged, but the fifth mast is probably an incorrect addition to the picture. If she had five masts the number must soon have been reduced.

and 19 feet pitch. There were six boilers, and her bunkers held 700 tons, and other accommodation enabled her to stow 510 tons more. To lessen the vibration experienced from the screw and machinery, eight new wrought-iron beams were placed transversely through the vessel, locking her sides together. The bases on which the machinery rested were made stronger, and she was further strengthened by massive iron entablature beams to the engines, buttressed by a framing of teak wood, each piece being 20 inches wide and 3 feet deep, running on either side of the engines transversely and diagonally to the sides of the ship. This solid timber extended 17 feet 6 inches on each side of the engine. The whole of this framing was bolted together and to the sides of the ship by wrought-iron bolts. The new arrangement of the boilers gave her a lessened coal consumption

Little more need be said about this steamer. She made one voyage afterwards to New York and back, and being then acquired by Messrs. Antony Gibbs and Sons was placed in the Australian trade at the time of the gold fever, and continued a regular voyage between England and Australia for many years. She was afterwards patched up afresh and had her engines removed, but was then such a failure that though she got as far as the Falkland Islands, leaking badly, she was abandoned to the underwriters, and is now ingloriously ending her days as a coal hulk.

CHAPTER IX

DEVELOPMENT OF IRON SHIPBUILDING

AFTER the launching of the *Great Britain* in 1845, steam-ship building was carried on with great activity, though the change from wood to iron and from paddles to the screw was gradual. Many wooden vessels, both steamers and sailers, continued to be built, as the prejudice against iron for ship construction died slowly. The screw propellers were at first simply auxiliary to sail. This was due to three causes: mistrust of the propeller, the cost of continually running it, and the difficulty of carrying sufficient coal.

Describing the gradual evolution of the steam-ship in its early days, Mr. John Ward, a director in Messrs. Denny's famous firm, in his Presidential Address to the Institution of Engineers and Shipbuilders in Scotland, in 1907, said:

"The necessities of the screw propeller after its general adoption demanded a much greater increase of engine revolution than constructors in the early days, or for some years after, deemed it prudent to adopt. Thus a great variety of design, including beam, steeple, oscillating, and other forms of machines were used, all with gearing between the engine and the propeller. But a few direct-acting engines appeared very early, and gradually,

as engineers gained confidence, the latter type became universal, and assumed the form of the inverted cylinder in the so-called steam-hammer engine which was the universal type for mercantile purposes until the end of the century.

"John Elder we may look upon as the father of multiple-expansion engines. He, together with his partner Charles Randolph, was trained in the marine school of Mr. Robert Napier, Vulcan Foundry, Glasgow. In 1852 they commenced business, and by 1856 had constructed several four-cylinder compound engines. Randolph, Elder and Co. entered into a contract for a set of engines, the coal for which, on trial, would not exceed 3 lb. per indicated horse-power per hour. The trial . . . worked out at $2\frac{9}{20}$ lb." In regard to coal consumption, the Pacific Steam Navigation Company's boats *Callao*, *Lima*, and *Bogota*, after being brought home from the Pacific coast to be re-engined, all showed a consumption of from 2 to $2\frac{1}{2}$ lb. (per indicated horse-power) of best Welsh coal. The *Bogota's* speed with the old engines was 9·75 knots and the coal consumption not less than 38 cwts. per hour. On her outward voyage with new engines she "gave a mean speed of 10·47 knots with 19 cwts. of coal per hour." The steam-pressure was 22 lb. and the horse-power was about 950 indicated.

"These early fathers seemed to see into the future. Walter N. Neilson, in his Presidential Address (1859), refers to the 'three grand requirements (of marine engines) as—a safe and suitable boiler for 100 lb. and upwards; a good arrangement of engine to receive the initial force of the steam without shock or liability to derangement, and carry out expansion to the greatest practical limits; and, lastly, an efficient surface condenser.

"John Elder was among the first to adopt the surface condenser and the cylindrical boiler, and he thus in the 'fifties brought to a successful issue these three grand

requirements. We must go back to these early days to realise what it meant to make a boiler which would be safe for 100 lb.; steel plates of the present day weighing tons were then represented by puddled iron plates weighing hundredweights. This led John Elder to try a water-tube boiler, practically the modern Yarrow boiler, also a spiral tube boiler, but probably none of these was successful owing to the salt-water difficulty, evaporators not being introduced till many years afterwards."

As the adaptability of iron for constructional purposes became more generally recognised, it led to the proposal that steamers should be built on the longitudinal principle instead of with an ordinary keel and a series of transverse ribs. The use of iron also enabled shipbuilders to increase the safety of their vessels considerably by means of transverse bulkheads, the number of these being increased until, even as early as 1838, the iron steamers then being built for the Glasgow and Liverpool line were each divided into five sections, any three of which were estimated to be sufficient to keep the steamer afloat if the other two should become waterlogged through collision. Several vessels were constructed on modifications of the longitudinal system, the chief among them being the *Great Eastern*. In 1853 James Hodgson of Liverpool issued a circular on the advantages of iron sailing ships, in which he pointed out not only the greater strength obtained by using iron but the comparative cheapness of construction. The circular stated that a wooden ship of 1000 tons would cost £16 10*s*. per ton, and an iron ship £13 10*s*. per ton, both fitted for trade to the East. The wooden ship would not carry more than 1500 tons, whereas an iron ship built from the same external lines would carry 1800 tons, and this difference at £5 per ton out and home, added to allowances for insurance, depreciation, and interest, would make a difference in favour of the iron ship of £2295.

THE "SARAH SANDS," 1846.

p. 230

What was true of sailing ships was equally true of steamers, and Hodgson had shown this some years before the publication of his circular, when he built the *Sarah Sands*.

The *Sarah Sands* afforded an excellent example of the strength of iron ships if well and substantially built. She grounded on the Woodside Bank in the Mersey when carrying 1000 tons dead weight, and remained high and dry until the tide flowed again, during which time she did not sustain the slightest damage. She experienced several mishaps at one time and another, which demonstrated not only the superior manner in which she was put together, but also the superiority of iron ships over wooden ones, for it is difficult to suppose that a wooden vessel would have withstood all these casualties without sustaining serious damage. The *Sarah Sands* was built in 1846 at Liverpool; she was 182 feet between perpendiculars, 33 feet beam, 32 feet deep, and of 1400 gross tonnage. Her engines were of 300 indicated horse-power and were built by Messrs. Bury, Curtice, and Kennedy of Liverpool. She had two oscillating cylinders of 50 inches diameter and a stroke of 3 feet, working upwards to the crank shaft, and a still greater novelty was the application of a direct coupling between the crank shaft and the screw shaft. Her boilers were of the wet-bottomed type, and had six furnaces besides return tubes, the steam pressure being 9 lb. She was four-masted and heavily canvassed, carrying courses, topsails, and topgallant sails on the main and mizzen masts, while she was fore and aft rigged, including topsails, on the fore and jigger masts; her head sails included a large fore staysail and two immense jibs.

She made her first voyage from Liverpool to New York in January 1847, in connection with the Red Cross Line, and remained in this service until the end of 1849, when she was transferred to the American coastal route between Panama and San Francisco, being probably the

first iron screw vessel to go round South America. The discovery of gold in Australia caused her to be sent to Sydney with a crowded passenger list of gold-seekers, and she was thus the first iron screw steamer to cross the Pacific to Australia; she afterwards came back to Liverpool and was again placed on the New York trade, and in 1854 was sent to Canada and was the first iron screw steamer in that trade also. On her return passage she struck the rocks in the St. Lawrence, near Belle Isle, and remained fast four days and nights. When she returned to Liverpool it was found that she had not started so much as a rivet, which says a good deal for the strength of her construction. This was destined to have another unnecessary proof, for as she left the graving dock she capsized owing to her ballast having been removed and not replaced, but again she was none the worse. Next she was employed as a transport for troops to India in 1857, and caught fire in her saloon, but as the hull was of iron the fire was subdued and she put into Mauritius with the whole after-part burnt out. This ended her career as a steamer, for she returned to England under sail and was converted into a sailing ship, and in the following year met with a disaster which even her tough frame could not withstand; she struck on the rocks near Bombay and went to pieces.

In 1850 several boats were designed for mail service in any weather for a run not exceeding sixty miles and on which sleeping accommodation was not required. One of the best of the type was *Her Majesty*, built and engined by Robinson and Russell in 1850 for the Portsmouth and Ryde station. She was an iron paddle-steamer. The engines had two oscillating cylinders 27 inches in diameter with 30 inches stroke, and made 58 revolutions per minute. Her tubular boiler, 9·75 feet long, 11·25 feet wide, and 6 feet high, developed steam at 20 lb. pressure. The heating surface was 1234 square feet. Engines, boilers, and water weighed 30·5 tons.

The paddles were 11·16 feet in diameter and each had nine fixed floats. There were three masts and the sail area was 64 square yards. Her speed was 12·8 knots; displacement, 93 tons; length, 127 feet; extreme beam, 26 feet.

The steamer *Crœsus*, for the Australian trade, launched at Mare's yard, Blackwall, in June 1853, for the General Screw Shipping Company, was the largest vessel yet built for the firm. She was of 2500 tons, with engines by Messrs. G. and J. Rennie, of 400 horse-power.

Messrs. Maudslay, like Messrs. Penn and other eminent engineers, had been in the habit of having the ships for which they contracted built by other firms, while they themselves supplied the engines. They decided to do their own shipbuilding, and accordingly opened a yard at East Greenwich. The first vessel launched there was the *Lady Derby*, of 530 tons gross, built for the General Iron Screw-Collier Company.

Those were the days when Thames shipbuilding was at its zenith. While trade was good, freights high, and ship-owning was profitable, shipowners did not mind paying high prices for their vessels; but as the north-east coast, the Mersey, and the east and west coasts of Scotland developed their iron shipbuilding facilities, and by reason of their proximity to the coal and iron fields were able to obtain these commodities at lower prices than the Thames shipbuilders could secure them, they were able to underbid the Thames shipbuilders and secure the industry, with the result that there is now but one shipbuilding establishment of importance in the Thames equipped to turn out a large warship or liner. Its competitors and neighbours of half a century ago vanished one after another. Some have passed out of existence, others have become merely repairing yards, and two or three have gone elsewhere and prospered. The one survivor is the Thames Iron Works and Shipbuilding Company, which, on the site made

historic by Mr. Penn's enterprise, proudly endeavours to hold its own and maintain the traditions of the river.

Mare's shipbuilding yards on the shores of Bow Creek, near its entrance to the Thames, started in a very small way, but within seventeen years it extended until it was employing nearly 400 hands. In 1845, a large portion of the Essex side of the yard was a marsh, covered with water at high tide. By 1854 it was one of the principal shipbuilding yards in the world. The wages of the workmen at Blackwall averaged for eighteen months £5000 per week, and some weeks it was £1600 more. The yards of Messrs. Green, Messrs. Scott Russell, Messrs. Dudgeon, Messrs. Maudslay, Messrs. Samuda, Messrs. Yarrow, and Messrs. Thorneycroft, to mention only a few, besides a host of smaller builders, employed their thousands of hands; but never a keel is laid there now. The banks of the river which rang to the stroke of the shipwrights' hammers are silent; the slips are unoccupied or devoted to other uses, the furnaces are cold; the machinery is sold or dismantled, and fragments of it may yet be seen rusting ingloriously on the scrap-heap. Dawn now brings no activity to the shipbuilding yards of the Thames, and dusk adds nothing to their stagnation. Steam-ship repairing work is nearly all that London river sees now. If, as sailors say, ships have spirits that return to the yards where the vessels were built, when those ships are lost or broken up, there must be many homeless phantoms haunting the banks of the historic stream, seeking rest and finding none, and perchance, as did certain of the ships they represent, going down the river with the tide never to return: a ghostly fleet bearing many mysteries which shall not be solved till the day when the insatiable sea is called upon to surrender all it has taken captive.

The general superiority of iron screw steamers over those of wood led to the introduction of a number of types designed to meet the requirements of special trades.

James Hodgson, who, in addition to the *Sarah Sands*, built the *Antelope*, the first iron screw steamer to leave Liverpool for the Brazils, introduced the tubular type of iron vessels. *The Carbon*, a vessel of this type, was built by him for the Eastern Archipelago Company in 1855. In the construction of this boat he proposed to dispense with the ordinary side frames altogether.

He stated in his synopsis that calculations of the strength of thirty frames, in a ship that had answered exceedingly well, showed that a partial bulkhead or frame projected from the side of the vessel to the extent of only 20 inches was more than equal in strength to the thirty frames, if it were supported on two bearings at a given distance and weighted on the upper side in the middle. This frame, of 20 inches deep, would carry more than the whole of the thirty frames, and when the bulkhead was extended across to the other side of the ship there would be a great preponderance of strength in favour of the bulkhead. But, in dispensing with frames, it might, in some cases, be necessary to increase the plating for the sides, to give some additional strength. Since the strength of the materials increased as the square of the thickness, the addition of one-eighth to five-eighths of an inch plate increased the strength to resist a blow sideways, or in a lateral direction, by nearly 50 per cent. The strength of the vessel was further increased by placing the bulkhead in the widest part of the ship, amidships, and by other bulkheads placed midway between the midship bulkhead and the bow and stern, should it be deemed advisable; and also by the interposition of stiffening plates. Other strengthening means were also recommended. The vessel would be, he contended, "capable of sustaining a considerable pressure, either externally or internally, having round, swelling, or convex sides, with a ridge or rib on the lower side which answers the purpose of a keel."

Vessels of this type were expected to be much more

economical to build, and no more expensive to run than those built on the ordinary lines. It was disputed whether a tubular vessel being without frames, floors, &c., would be strong enough for all purposes. An accident to Mr. Hodgson's tubular cargo vessel, *The Carbon*, however, seemed to justify his contentions, for she stranded badly when being launched, so that her stern was submerged at high water. She was towed up the slip again, and refloated, and it was found that only two plates required repairs. *The Carbon* was running until quite recent years in the east coast coal trade to London.

Another important development in construction was due to Mr. J. Scott Russell, who has been described, like Sir I. K. Brunel, as a man before his time. Mr. Russell's services to steam navigation in his exposition of the wave-line theory of ship construction were of incalculable benefit to the science. His object was to diminish the resistance offered by the water to the passage of the ship, and the modifications he made in the lines of the hull not only effected this to a very remarkable degree, but also increased the seaworthiness and speed of the vessels. He designed a number of small vessels suitable for special trades or to meet particular requirements.

One introduced about 1855, for North Sea work, was an iron screw steamer with a long parallel middle body which made a capacious ship, the fore and after parts being designed in accordance with his wave-line theory. Another of his cargo vessels, having a greater length of parallel middle body and wave-line ends, had the screw propeller abaft the rudder, which was entirely below the propeller shaft, there being a loop in the rudder stock through which the propeller shaft passed. A second vessel of this type, but rather longer in proportion to its beam, was designed for the Baltic trade, and had the peculiarity that its forecastle extended as far as the midship deck-house.

THE "CITY OF GLASGOW" (INMAN LINE, 1850).

p. 236

DEVELOPMENT OF IRON SHIPBUILDING

The period from 1845 to 1880 is remarkable for the progress made in steam-ship building prior to the general adoption of steel for the construction of ocean vessels.

The early history of the Cunard Line has already been related. Before the last wooden Cunarders were built, the Inman Line appeared on the scene with a service of iron steamers with screw propellers, the first being the *City of Glasgow*, launched in 1850 by Tod and McGregor on the Clyde, for a transatlantic service they themselves intended to establish with Glasgow as its headquarters. The side-lever engine of the ordinary type was modified for this vessel, as it was fitted with two beams working across the ship. The cylinders were on one side of the ship, and on the other was a large wheel which geared three to one with ordinary teeth into the propeller-shaft pinion. Her machinery was placed low down in the hold so as to leave her decks as free of encumbrances as possible.

She was a three-decked vessel of 1069 tons gross, 227 feet long by 33 feet beam and 25 feet depth; and her engines of 350 horse-power drove a two-bladed screw of 13 feet in diameter and 18 feet pitch. She was designed to carry 52 passengers in the first class; 85 in the second class, and 400 in the steerage, and a crew of about 70. The hull was divided by five water-tight bulkheads into six compartments, and as a further provision for the safety of her passengers and crew she carried six lifeboats. Her fresh-water tanks contained no less than 13,000 gallons. She was barque-rigged, of almost yacht-like lines, and had a graceful clipper bow. The *City of Glasgow* made a few voyages between Glasgow and New York in the spring and summer of 1850.

Mr. William Inman of Liverpool had meanwhile been preparing for the establishment of a line of steamers between Liverpool and America. His idea was that modern iron vessels, equipped with screw propellers, were bound to supersede paddle-wheel vessels, and also that

there was money to be made in the emigrant trade. His decision to place fast steamers in this trade, however, was as much philanthropic as commercial, for he was profoundly moved by the reports of the sufferings and inconveniences experienced by emigrants in sailing ships, no less than by the accounts of the fearful mortality among them. The carrying of emigrants was, at that time, confined to sailing ships, many of which were wholly unsuited to the purpose. The steamer companies catered chiefly for those who could afford to pay well. Mr. Inman determined to cater for the emigrant traffic also, and for forty-two years the line bearing his name was pre-eminent in this branch of the work of the Atlantic ferry.

Practically the only steamer which met the requirements he had in mind was the *City of Glasgow*, and in the autumn of 1850 she was acquired by the founders of the Inman Line.

"It was on December 10, 1850, that the Liverpool and Philadelphia Steamship Company was established. Their agents were Messrs. Richardson Bros. and Co., who had already a number of packet ships of their own. They were the chief owners of the *City of Glasgow*, and their junior partner was Mr. William Inman, who managed the shipping department of the business." This extract from the "Official Guide" of the Inman and International Steamship Company Ltd., published about 1888, is of interest in view of the various accounts of the inception of the company which have been made public. The first sailing of the *City of Glasgow* for her new owners took place on December 17, 1850, from Liverpool for Philadelphia. She was under the command of Captain Matthews, who formerly had charge of the *Great Western*.

In June 1851, the *City of Manchester*, by the same builders and also of iron, was purchased by the Inman

organisation. She was of 2125 tons and carried "overhead" or "steeple" geared engines of 350 horse-power. Her cylinders and proportion of gearing, however, were identical with those of the *City of Glasgow*.

In October 1851 the *City of Pittsburg* was built at Philadelphia and was the first American-built screw-propelled steamer in the North Atlantic service. The *City of Philadelphia* was delivered by Messrs. Tod and McGregor in 1853, being of slightly greater tonnage than her predecessor from the yard; but she was eclipsed by the *City of Baltimore* ordered the same year, the dimensions of the last named being: 326 feet in length, 39 feet breadth, 26 feet depth, 2472 tons gross and 1774 net.

This vessel took the place of the *City of Glasgow*, which in March 1854 disappeared in mid-ocean with 480 souls on board. In September of the same year the *City of Philadelphia* was wrecked off Cape Race, but there was no loss of life.

"Inman's iron screws," as they were dubbed, were attracting attention, and it was recognised as merely a question of time when steamers of this type would prove successful rivals to the paddle-boats.

Mr. Inman became sole managing director in October 1854, as the result of the offer of the British Government to charter certain of the steamers as transports during the Crimean War, the use of the vessels for this purpose being disapproved by Messrs. Richardson, who were Quakers. About this time the company purchased the *Kangaroo* from the Pacific and Australasian Company, and ordered the *City of Washington* from Messrs. Tod and McGregor. The *Kangaroo* was 257 feet in length, 36 feet in breadth, 27 feet depth, and had a gross tonnage of 1719 tons. The *City of Washington* was 358 feet in length, 40 feet in breadth, and 26 feet depth, with a gross tonnage of 2870 tons.

The Crimean War saw a great demand by the Allies

for transports, and as the French Government offered better terms than the British Government, the *City of Manchester* was chartered to the French, and was followed by the *City of Baltimore*, and six months later, when she had concluded her trial trips, by the *City of Washington*. Upon the termination of their engagement as transports these vessels returned to the Liverpool and Philadelphia service.

For some time Mr. Inman had been considering the advisability of making New York his American port instead of Philadelphia, and when the *Kangaroo*, with all her passengers on board, was frozen up in the Delaware and her departure for Liverpool was delayed for five weeks, he inaugurated, in December 1856, a monthly service to New York with the *City of Washington*. Two months later the Inman sailings were increased to fortnightly, the sailings in the alternate weeks being undertaken by the Collins liners. This arrangement was very short-lived, for in the same month the Collins Line service was withdrawn. In 1857 also, the title of the organisation was changed to "The Liverpool, New York, and Philadelphia Steamship Company," to mark the extension of the service to New York.

In October 1857 Mr. Inman's Company bought up the Glasgow and New York Steamship Company, and placed two of the vessels, the *Edinburgh* and the *Glasgow*, in the trade between Liverpool and New York. By 1860 the demands upon the resources of the line were such that the first *City of New York* was ordered from Tod and McGregor. She was 336 feet in length, by 40 feet beam, and 28 feet depth, and was of 2360 tons gross. Her engines were of the horizontal, trunk type, and she was the first vessel of this line in which engines of this design were installed.

The rivalry between the Inman and Cunard Lines was intense, and neither company produced a steamer which

the other did not seek to surpass, but the Inman Company forged ahead both in the matter of speed and passenger accommodation and became for a time the premier company on the Atlantic. The White Star Line, however, entered the "ferry" with vessels of a different type, and the competition between the three great companies became keener than ever. The first *City of Paris* was added to the fleet in 1866. Her Cunard rival was the *Russia*. The *City of Brussels*, of 3081 tons, began her sailings in October 1869. She was the last of the Inman Line to be fitted with the long wooden deck-house which was a conspicuous feature of so many ocean-going steamers. Her average speed was between 14 and 15 knots, which was slightly increased when she was re-engined in a few years' time. In December 1869 she made the voyage from New York to Queenstown in 7 days 20 hours 33 minutes, a record which remained unbeaten until September 1875, when the *City of Berlin* made the westward passage in 7 days 18 hours and 2 minutes, and the homeward run in 7 days 15 hours 48 minutes. The *City of Brussels* was the first vessel, apart from the *Great Eastern*, in the North Atlantic trade, in which McFarlane Gray's steam-steering gear was introduced.

The dangers inseparable from the North Atlantic traffic led to the adoption by the company in 1870 of the "lanes" or routes across the ocean as suggested by Lieut. Maury of the United States Navy, a more southerly course being taken during the months from January to August, to avoid the icebergs from the northern regions. The Cunard and other steam-ship companies adopted the system about the same time.

The *City of Berlin* was contracted for by Messrs. Caird and Co. in 1873, and when she was launched the Inman fleet counted up thirty-one vessels with a total of 76,766 tons. The rivalry between the builders of the

great ocean-going liners, no less than between the firms owning the ships and the officers of the ships themselves, was very great, and Messrs. Caird were successful in their endeavour to turn out a vessel which should be admitted to be the finest ocean-going steamer afloat. The rapid acquisition of one first-class vessel after another placed the Inman Company in the front rank. This steamer was 489 feet long on the keel, and 513 feet over all, by 45 feet beam and 36 feet depth. Her speed was about 16 knots. She was of 5491 tons gross and 3139 tons net. She had a pair of engines of the inverted direct-acting compound type, with high- and low-pressure cylinders, and of 1000 nominal horse-power, but on her trial trip the indicated horse-power was 5200, and this was sometimes exceeded in her voyages. Her low-pressure cylinder was 120 inches in diameter, and the high-pressure was 72 inches. Her twelve boilers were heated by thirty-six furnaces, the boilers being so arranged that any number of them could be cut off.

It was pointed out by the *Nautical Times* that while the nominal horse-power of the *City of Bristol*, added to the fleet in 1860, was as one to ten as regards the gross tonnage, that of the splendid *City of Berlin*, put on the line in March 1875, was as one to five and a half. She could accommodate 400 passengers, of whom 200 were in the saloon, 100 in the second cabin, and the remainder in the steerage, and her crew numbered 150. Electricity as a means of lighting was introduced into the trans-atlantic trade on this steamer in November 1879.

All the Inman vessels hitherto launched were ship-rigged, and all had the graceful clipper bows for which the line was famous, the Inman fleet being unequalled for beauty. At times, as they were overhauled, they were barque-rigged, and one or two were given a three-masted schooner rig.

In June 1881 the beautiful *City of Rome* was launched

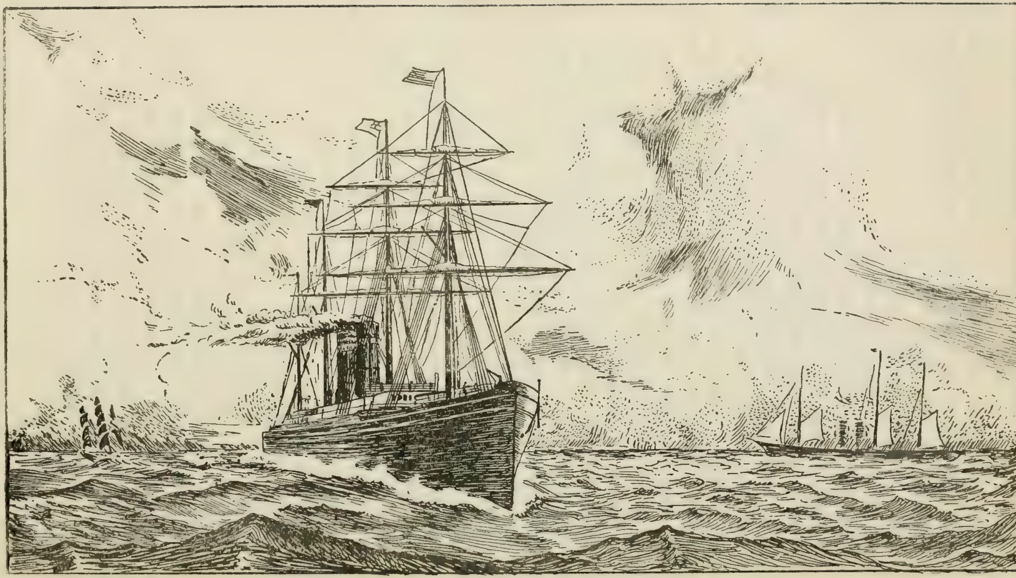
THE "CITY OF ROME" (INMAN LINE, 1881).

p. 212

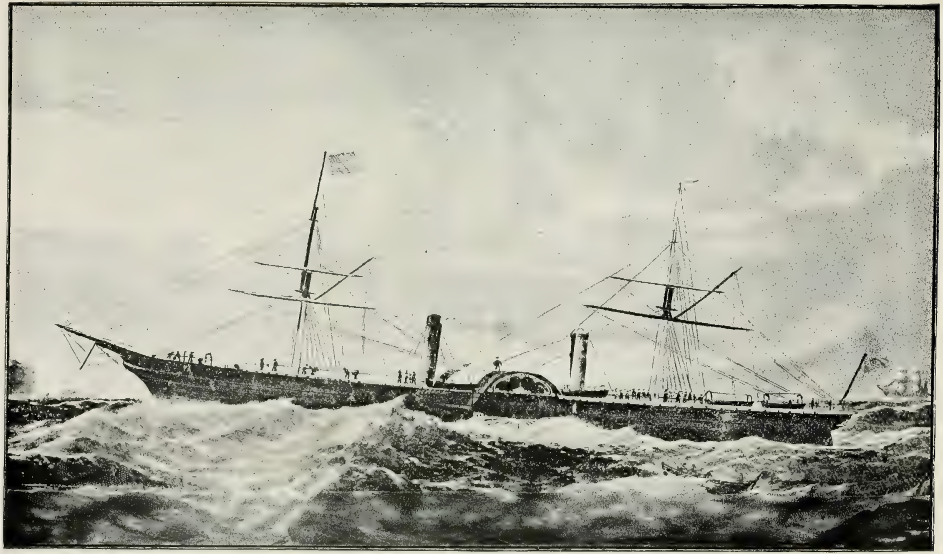
at Barrow for the company, and sailed on her maiden voyage in the following October. She was constructed of iron throughout, and was 560 feet in length by $52\frac{1}{2}$ beam and 37 feet depth, and was of 8144 tons gross. This was the first of the company's steamers to have three funnels, and being placed between the main and mizzen masts at regular spaces they served to add to the appearance of the vessel. Her machinery marked another important innovation as, although the engine was on the three-crank system, it had three high-pressure cylinders of 46 inches diameter each, and three low-pressure cylinders of 86 inches diameter each, arranged on the tandem method, and the piston had a stroke of six feet. The eight boilers worked up to 90 lb. pressure, with forty-eight furnaces so arranged that a water-tight bulkhead was fitted fore and aft and formed the coal bunkers, but this arrangement was modified afterwards. This splendid vessel did not come up to expectations in the matter of speed and was returned to the builders.

In 1875 the company was converted into the Inman Steamship Company, Ltd. The *City of Rome* was the last steamer the founder of the line ordered, and he died before her completion. No further additions were made to the fleet of the Inman Company. After the company and fleet were acquired by the International Navigation Company in 1886, the new firm also bought the *City of Chicago* while she was on the stocks for the Dominion Line. This vessel was the only one under the Inman flag to have a straight stem. She ran for several years, and was then lost on the south coast of Ireland.

The first iron steamer built by the Cunard Company was the *Persia*, and she deserves more than a passing mention because of the association with her of David Kirkaldy, Napier's draughtsman, to whom modern steel shipbuilding owes the discovery of the way to toughen steel and remove its brittleness. Kirkaldy's drawings of



THE "CITY OF CHICAGO."



THE "PERSIA" AND "SCOTIA" (CUNARD, 1856 AND 1862).

p. 244

the *Persia* are stated to have been the only steam-ship designs ever exhibited at the Royal Academy. He was also the first on the Clyde to give the question of trial performances the attention it deserved. The first trial trips recorded by him, on the *Larriston*, on September 22 and October 18, 1852, were printed when the Admiralty asked for particulars of the respective behaviour of a Smith's and a Griffith's propeller. But he was not allowed to continue his researches in this direction, and even the *Persia* left the Clyde without a single diagram having been taken, for although Kirkaldy was in the engine-room during the entire trial, he had not permission to record her performances. He obtained data concerning many vessels "so as to be able to deduce the variations of behaviour and relative economy, and trace such to their respective origins, *e.g.*, whether any variation was due wholly or in part to the difference in the shape of the vessels, in the propellers, in the engines, or in the boilers. The utility of these investigations was signally demonstrated in the case of two vessels, *Lady Eglinton* and *Malvina* . . . the former proved a great success on her trial trip, and the latter a comparative failure. He was able to trace the cause of the failure and in great measure to rectify it. He clearly foresaw that the time was surely approaching when his employers would require to estimate for and construct vessels to fixed requirements as to draught, speed, and economy of working." *

The drawings of the *Persia* were made for his own pleasure, and the first intimation of their existence was the announcement in the papers that they had been admitted to the Academy. By Napier's instructions they were exhibited at the Paris Exhibition of 1855 together with drawings of the steam-ships *Europa*, *America*, *Niagara*, and *Canada*. Napier received a gold medal and

* "Illustrations of David Kirkaldy's System of Mechanical Testing," by Wm. G. Kirkaldy.

the Legion of Honour as exhibitor, and Kirkaldy received a medal as draughtsman. The drawings of these four ships were placed in the Louvre Museum after being presented to the Emperor Napoleon.

The *Scotia*, the second and last of the Cunard iron paddle-steamers, followed in 1862. She was 379 feet in length, of slightly greater beam and depth than the *Persia*, and of 3671 tons, and her engines of 4900 indicated horse-power gave her a speed of nearly 14½ knots. The *Persia* was sold in 1868, and was converted into a sailing ship. The *Scotia* was kept in the service as long as possible, as she was a favourite with the public, but her very limited cargo space and her immense consumption of coal made it impossible to run her except at considerable loss. She was consequently withdrawn in 1875, and sold to the Telegraph Construction and Maintenance company, which had her re-engined and turned into a twin-screw boat. She remained in the service of this company for many years, and was used for cable-laying purposes. These were not, however, the Cunard Company's first iron steamers, as they had already had for some time two smaller vessels of iron in their Liverpool and Continental service.

By this time the Cunard directors were convinced, by the success of the Inman steamers, and by the advice of the engineers whom they consulted, that the paddle-steamer had reached its utmost point of development. Henceforth they built screw steamers, the first being the *China*, launched in 1862, and followed by the *Java* in 1865, and the *Russia* in 1867.

The *Russia*, and the Inman steamer *City of Paris*, the finest commercial vessels afloat, left New York on the same day in February 1869, within about an hour of each other and arrived at Liverpool with only thirty-five minutes difference between them. They made the run across the Atlantic, with the twenty minutes' stop at

THE "CHINA" (CUNARD, 1862).

THE "RUSSIA" (CUNARD, 1867).

p. 246

Queenstown, in about eight days, eighteen hours. The *City of Paris* started first, and got in at 3.45 A.M., and the *Russia* at 4.20. The vessels were in company for four days. Once the *Russia* passed the *City of Paris*, but the Inman liner took the lead again, and at another part of the voyage the Cunarder recovered her lost ground. As racing, however, was strictly forbidden by the rules of the two companies, and the ships' logs showed that no extra pressure of steam was used, it is supposed that in this, as in many other cases of supposed ocean racing, the race existed mainly in the imagination of the passengers, who for lack of anything else to do worked themselves up into a frenzy of excitement about it. The captains, of course, merely concerned themselves with putting in all the seamanship they knew. Pictures published at the time show that both vessels were under full sail, and even carried stunsails.

The *China*, after some years' service, was sold and converted into the sailing ship *Theodor*, and proved as fast after the change as when a steamer. She foundered at sea in 1908.

In 1866 another competitor appeared on the North Atlantic. The fate of the Collins and Galway Lines did not deter Mr. S. B. Guion from inaugurating a rival service to that maintained by the Cunard and Inman Lines, and for a time it seemed as if he would be successful in wresting from the splendid vessels of these companies the premier position on the Atlantic. The steamships which he placed on the service between Liverpool and New York were at that period superior in size, speed, and luxury to any of their competitors. He started the service with the *Manhattan*, and thus inaugurated in 1866 what may be called the great race of the greyhounds of the Atlantic. The *Manhattan* was built by the Palmer Company of Newcastle-on-Tyne, and was the first of seven steamers comprising the line. Her length was 343

feet, her beam 42 feet 6 inches, and her depth 28 feet, and her register was 2866 tons. She had accommodation for 72 passengers in the first class, and 800 in the second class, and besides taking 1000 tons of coal could carry 1500 tons of cargo. A feature of this vessel was the attention paid to the comfort of the second-class passengers, the cabins for this class being on the main deck and thoroughly ventilated, wherein they showed a marked improvement on the many other vessels carrying emigrants. She was fitted with low-pressure inverted direct-acting surface condensing engines, designed by Messrs. J. Jordan and Co. These had cylinders of 60 inches in diameter, with a piston stroke of 42 inches. The *Chicago* and the *Merrimac*, sister ships, followed from the same builders. The *Chicago* was wrecked in a fog on the rocks near the entrance to Cork Harbour, and, a contrast to some of the disasters to Atlantic liners, not a life was lost, the whole of the passengers and crew, numbering 130, being landed by the ship's boats within an hour of the accident. The earlier Guion liners were brig-rigged steamers, and some of them carried the new American double topsails on both masts. Other boats which formed a part of the earlier fleet of the Guion Line were the *Nebraska*, *Minnesota*, *Colorado*, *Idaho*, and *Nevada*. In 1870 these were augmented by the *Wyoming* and *Wisconsin*, also built and engined by Messrs. Palmer. These were each 366 feet long, 43 feet broad, 34 feet deep, and of 3238 tons register. Among other distinctive features they had the first compound engines on the transatlantic route. These had one vertical high-pressure cylinder of 60 inches in diameter, and one double-trunk horizontal low-pressure cylinder of 120 inches in diameter, both working on the same crank, and having a stroke of 42 inches. Great expectations as to speed were entertained when the *Montana* and *Dakota*, from the Palmer yards, were brought into the service in 1872. They exhibited a new

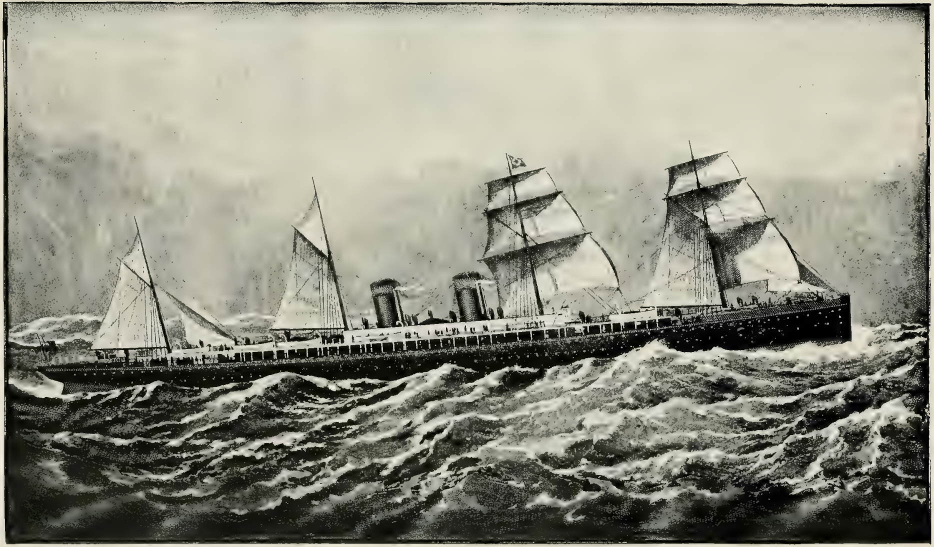
Model of the "City of Paris," 1866.

p. 248

design in hull and machinery as they had an abnormal slope of side, flush steel plating, and water-tube boilers. These vessels each had a length of a little over 400 feet, with a breadth of 43¾ feet and a depth of 40¾ feet. Like the *Wyoming* and *Wisconsin*, they had compound engines, one high-pressure cylinder of 60 inches diameter, working inverted on a forward crank, and two low-pressure cylinders working horizontally on the after crank. The *Montana's* boilers were constructed of a series of cross-tubes 15 inches in diameter and were intended to carry a head of 100 lb. of steam, but in consequence of an explosion when at 70 lb. pressure, they were replaced by ordinary tubular boilers with a pressure of 80 lb. of steam. The *Dakota* was wrecked on the Welsh coast in May 1877, and a similar fate befell the *Montana* three years later. Seven years passed and then the *Arizona* was brought into the Guion service. She was of iron and was built and engined by Messrs. John Elder and Co. of Glasgow. Her dimensions were: 450 feet long, 45⅛ feet broad, 35¾ feet deep, with a register of 5147 tons. She differed from the earlier boats of the line by being four-masted, carrying square sails on the fore and main masts, having two funnels, and having her saloon accommodation amidships; in all these particulars, as well as in the straight cutwater, she bore a strong resemblance to her rivals of the White Star Line.

Athough there was no deviation in her hull from the existing type, her machinery displayed some novel features. Her engines were compound with three crank shafts, each having one cylinder. The high-pressure cylinder was 62 inches in diameter, and was placed in the centre, between the low-pressure cylinders each of 90 inches, and all had a piston stroke of 66 inches. Steam was generated in seven boilers capable of withstanding 90 lb. pressure, and furnished with thirty-nine furnaces, which had an average coal consumption of 125 tons per day, or in round

figures 25 per cent. in excess of her fastest rivals, which were then in the White Star Line. On her homeward voyage from New York in July 1879, the *Arizona* succeeded in breaking the record, and repeated the feat on her outward passage in May 1880, when she made the passage from Queenstown to New York in 7 days, 10 hours, 47 minutes, thus proving herself for two years in succession the fastest boat on the Atlantic. While on her homeward passage in November 1879, the *Arizona* collided at full speed with an iceberg. Although she gave the berg a direct blow she is one of the few vessels that have managed to survive after such an experience. It was stated at the time that there was a projecting spur of ice from the berg under water, and on this the ship slid. Her weight caused the berg to rock, and it was to this circumstance alone that she owed her safety, for the rocking of the huge mass of ice enabled her to slip off the spur into deep water again. A tremendous quantity of ice, dislodged by the shock, crashed down upon her deck, doing a considerable amount of damage, and she had only drifted a few hundred yards from the berg, after the impact, when an immense portion of it fell at the spot where only a few moments previously the ship had rested. This is one of the narrowest escapes recorded in the annals of the sea. Fortunately, her collision bulkhead withstood the enormous strain, and the vessel received a magnificent, though entirely undesired, testimonial to the soundness and stability of her construction. She put into St. John's, Newfoundland, and was found to be so badly damaged that she had to have entirely new bows. The success of the *Arizona* led to the building of the *Alaska*, which proved another triumph for Messrs. John Elder and Co., for the speed she developed won her the title of the Atlantic Greyhound, her homeward passage in June 1882 being less than seven days. This remarkable run was, however, eclipsed by the *Oregon*, the last vessel added by the



THE "OREGON" (CUNARD AND GUION LINES, 1883).

p. 250

Guion Company prior to its dissolution; she sailed from Liverpool to New York on October 6, 1883, and accomplished the passage from Queensland to Sandy Hook in 6 days 10 hours 9 minutes. The *Oregon* was an iron vessel built and engined by Messrs. John Elder and Co., on similar lines to, but of greater dimensions than, the *Arizona* and the *Alaska*. She was no less than 500 feet in length, 54 feet wide, 40 feet deep, and registered 7375 tons. Her engines were compound and consisted of one 70-inch high-pressure cylinder placed in the centre, and two low-pressure 104-inch cylinders, with a 6-foot stroke; her boilers had a steam-pressure of 110 lb., and her average daily consumption of coal was 310 tons.

From about this time the passenger service across the Atlantic began to assume proportions and a degree of importance to which it had never before attained. Hitherto the steamers engaged on the transatlantic route had depended considerably on their cargo capacity as a means of meeting expenses, but with the demand for larger and faster vessels—and faster vessels could only be made larger—there was developed an express passenger boat which depended almost wholly on its passenger accommodation and carried a much smaller amount of cargo than some of the older and smaller vessels then engaged in the trade. The Guion Line did not wholly meet these requirements, and on the death of Mr. S. B. Guion, the line gradually dropped out of existence, the remaining vessels of the famous fleet of steamers being dispersed in various directions. Some years before this happened, however, the White Star Line began to build steamers for the Atlantic.

The White Star Line has always been the line of big ships. In its sailing-ship days it owned some of the finest wooden clippers afloat, famous alike for their size and speed. When Mr. T. H. Ismay in 1867 took over the management of the line and formed with some friends

the Oceanic Steam Navigation Company, there were already in existence the Cunard, Inman, Guion, and National Lines, which had secured such control of the Atlantic trade that it seemed almost rashness for the new line to venture to compete with them. "Nothing venture, nothing win"; the line now holds a position second to none in the world for the magnificence and size of its steamers. All its vessels have been built by Messrs. Harland and Wolff at Belfast. The first of the fleet was the *Oceanic*, launched on August 27, 1870, which started on her maiden voyage and the inaugural voyage of the fleet on March 2, 1871. Several vessels of the same type followed in rapid succession, all having the straight stem, four masts, and single funnel which were the distinguishing marks of the White Star steamers in those days. The *Oceanic* was 420 feet long, 41 feet beam, 31 feet deep, and had a registered tonnage of 3707. These steamers were somewhat differently designed from the other boats on the North Atlantic. The high bulwarks and narrow wooden deck-houses were dispensed with, and instead another iron deck was added with open iron railings round it, there being thus nothing to hold any water that might come on board. The saloons were amidships and extended the entire width of the vessel, and the staterooms were placed before and after the saloon and were better lighted and ventilated than those of any other steamers. The engines also were of a novel type; they were compound, four-cylindered, and arranged tandem, with two high-pressure cylinders each 41 inches diameter and two low-pressure each 78 inches in diameter, working on two cranks and having a stroke of five feet. The engines were arranged fore and aft, and each formed a complete engine in itself, so that either could be worked in case of accident to the other. The *Oceanic* inaugurated the era of the modern type of express ocean liner. After a few voyages some altera-

tions were made in her, which added to her efficiency, her masts being shortened, and a whaleback being built over her stern. In 1875 she was transferred, together with her sisters the *Belgic* and *Gaelic*, to the Pacific to inaugurate the White Star steam service between Hong-Kong, Yokohama, and San Francisco.

Two famous sister ships the White Star Line had were the *Germanic* and *Britannic*, built in 1875 and 1874 respectively; they were each 455 feet long, 45 feet broad, 33 feet 9 inches deep, and of 5004 tons register. The hulls were built at Belfast, but the engines were by Maudslay, Sons and Field and similar to those of the *Oceanic*. With a speed rather above 16 knots, they were the first to reduce the passage to below seven days. Numerous experiments were made with a lifting propeller in the *Britannic*, but they were not a success and the principle was never tried in any more of the company's boats. The company sought also to improve the lighting of their steamers. The old system of lighting a ship by candles was seldom more than enough to make the darkness visible, and oil lamps were not always much better; so an attempt was made to install a gas-lighting apparatus. It worked very well while the vessel was in port, the experiment being made on the *Adriatic* in 1872, and the *Celtic* in 1873; but there was a certain amount of leakage through the working of the ship in a sea-way and the experiment was abandoned. Oil lamps were then installed in these steamers and remained in use until superseded by electric light. Another White Star experiment was with the oscillating saloon, intended to keep berths and staterooms level while the ship was rolling, but this was no more a success on the broad Atlantic than it was on the English Channel when tried in the steamer *Bessemer*.

Other lines which have played a conspicuous part in the North Atlantic trade are the State, the Beaver, and

the National Lines, all of which owned some very fine steamers. The last named was founded to run a line between Liverpool and the ports of the Confederate States when the war should terminate, but it proved a financial failure and the promoters then decided to enter the Liverpool and New York trade. Its three vessels, *Louisiana*, *Virginia*, and *Pennsylvania*, were the largest cargo-carriers on the ocean, being of nearly 3500 tons gross. Three larger steamers, *The Queen*, *Erin*, and *Helvetia*, were added in 1864, and three more in the next two years. The *Italy*, of 4300 tons, was regarded as a wonderful ship on account of her size, and is stated to have been the first of her type in which compound engines were fitted. Other and larger steamers were added to the fleet to meet its extensive requirements, until it sustained not only a weekly service each way between Liverpool and New York, but also had regular sailings from London to New York, calling at Havre. Its steamers were not beautiful or fast, but were very steady, made cargo-carrying a feature, and conveyed a great number of emigrants. Then the National Line surprised every one by bringing out in 1884 one of the most beautiful and graceful steamers ever seen on the Atlantic, and certainly the fastest of her day—the *America*, which, as she was built of steel, belongs properly to a later period of ship construction. She was 5528 tons gross, built and engined by Messrs. J. and G. Thomson, and was sold in a few months to the Italian Government. Some years later the line began to decline and it is now a part of the "Combine," only two or three vessels being under its flag.

The first mail steam-ship line between Liverpool and Canada was started by McKean, McLarty, and Lamont of Liverpool in 1852 under contract with the Government, but the effort was a failure, and in the next year H. and A. Allan undertook the work. Their first steamer was the *Canadian* in 1853, followed by the *Indian*, *North*

THE "AMERICA" (NATIONAL LINE, 1884).

p. 254

American, and *Anglo-Saxon*, and as the Grand Trunk Railway was completed next year to Portland, this town became the winter terminus of the line and Montreal the summer terminus. Upon the completion of the inter-colonial railway in 1876, connecting Quebec with Halifax, the Nova Scotian port became the winter terminus of the Allan Line. By 1882 the service had increased to such an extent that the sailings were made weekly instead of fortnightly. In 1862 the Allans established a line between Glasgow and Montreal; a few years afterwards sailings were made between London and Canada, and more recently still Continental calls were added.

The Donaldson Line, established in 1855, has for many years maintained a service between Glasgow and Montreal, its vessels ranging from sailers to some of the finest steamers entering the St. Lawrence River. Its present service is performed with the twin-screw steamers *Athenia* and *Cassandra*, and nine single-screw boats; and another twin-screw boat, the *Saturnia*, is shortly to be delivered, and will be of about 8000 tons, the largest in the company's fleet. The salient feature of the Donaldson Line passenger steamers is the carriage of one class of cabin passengers only, called second cabin. This enables travellers to enjoy the best the ships afford, the accommodation being equal to that on many long-distance steamers, such as those that go to Australia. Its first steamer to Montreal was the *Astarte* in 1874, upon the withdrawal of the line from the South American trade in which it had been engaged up to then; and its Canadian service, fortnightly at first, became weekly in 1880. A line to Baltimore, Maryland, was established in the winter of 1886–7, and the winter service to Canada began with the Baltimore boats calling at Halifax on their west-bound voyages.

No further attempt was made by the Americans to establish a line of steamers across the Atlantic until 1871,

but in that year Messrs. Cramp of Philadelphia received orders for four large steamers of over 3000 tons each, and these with some English vessels maintained the service of the American Line. In 1884 the Red Star Line took over the line and ran the boats as cargo steamers. They were again transferred in 1893 to another American Line which three years later sold them. In the meantime, the later American Line ordered a number of vessels and, besides buying up the Inman Line, absorbed the Inman and International, which owned the steamers *City of Paris* and *City of New York*. The new owners dropped the words "City of," and also had two steamers built in America to comply with the Act of Congress under which the line was formed.

The screw propeller was naturally not long in commending itself to the builders of ships for the long voyages to India and Australia.

Mr. John Dudgeon, in an article published in 1856 on steam expansion and the suitability of expansion engines for long voyages, was almost prophetic in his remarks on the relative value of the screw propeller and the paddle-wheel. In the article he said:

"The application of this property in steam to Australian screw steam navigation, would, if adopted, effect a radical change in the whole question. When we find that vessels of the magnitude of the *Great Britain* have to run thousands of miles out of their course to get a fresh supply of coal, it becomes a question whether that state of matters may not be amended. I therefore propose that vessels of, say, 2000 tons be built and fitted with engines working up to 1100 horses actual power, which would . . . consume 1609·5 lb. of coal per hour, and with this power the vessel would steam at least 10 knots an hour . . . equal to 19 tons 4 cwt. per day and a speed of 240 knots; 500 tons of coal would therefore be enough for a run of twenty-five days, and 6000

nautical miles. Should it be deemed prudent to carry a reserve stock, coal for an additional 1500 miles would still not seriously interfere with the carrying properties of a large vessel, while it would obviate the necessity of having any stoppage but the Cape between Great Britain and Port Phillip. A vessel of 2000 tons builders' measurement will carry at least 2000 tons dead weight, over and above her own weight of ship and machinery. Presuming that she takes coal for 9000 miles, or 750 tons, we still have a balance of 1250 tons for cargo and, in a well-arranged vessel, room for 350 passengers. Now I apprehend that as regularity and multiplied means of communication are the prime wants in all commercial matters, we should do better to sail such ships as these, with frequent departures, than if we were to build vessels of double the size, and have double the time to wait for a full freight and a full complement of passengers. No doubt that in a vessel double the size we may manage to carry coal for the whole distance to Port Phillip, but I apprehend that the delay of waiting for freight and passengers would more than balance the delay of coaling at the Cape. It must also be cheaper to send out coals in vessels adapted for the trade of carrying coal, than to occupy the valuable room in even a large vessel which ought to be appropriated to the carriage of that class of goods which will pay for rapid steam communication. The sole question at issue is: Can a vessel of from 2000 to 3000 tons be worked with an economy equal to a vessel of from 4000 to 6000 tons? I contend that not only is such the case, but that the balance of returns, and convenience to the public, must be in favour of the moderate-sized vessel. With such Leviathan vessels there is, first, the double outlay upon one ship and corresponding interest of capital; secondly, there is a double risk in case of losing the ship; a correspondingly higher premium of insurance; additional risk of not having full cargo; additional time required for procuring freight, stowing, and

loading vessel, and the almost impossible feat to be performed of finding a sufficiently large body of passengers ready to go at the same time ; the impossibility of entering the ordinary docks in the kingdom necessitating the use of a port of embarkation at a distance from the main channel of business. The whole of these weighty objections then have to be balanced by the economy theoretically presumed to be attainable by the increased capacity of vessels for carrying coal, cargo, and passengers. It appears obvious that coal-carrying can be done cheaper by auxiliary vessels, where the station is in a direct line, than by the vessel carrying them herself. It is only when the power of carrying coal is so small or the consumption is so large, that the vessel is forced to make a great number of stoppages, and make considerable detours to arrive at coaling stations, that stopping to coal becomes so serious an evil."

The writer goes on to contend that the propeller should be placed outside the rudder, so that a coarse pitch may work with proper effect, "as it is clearly proved that working the propeller in the deadwood destroys a large portion of its useful effect, so much so that an increase in the pitch of a propeller to the extent of one-third does not show more slip (when used behind the rudder) than the two-thirds when used before it." He further contended that the proportion of stroke to diameter should be greater in an engine that is to drive a screw propeller direct than what is required for applying the same power to a paddle-wheel, and it would soon be found that as an instrument of propulsion, even for great speed, the screw would not be inferior to the most approved patent paddle-wheel.

One has only to read a declaration of this character, by one of the leading shipbuilders of his day, and then compare the situation, the difficulties of which appeared to him wellnigh insuperable, but every one of which has passed away, with the frequent sailings of the enormous

vessels which journey the whole of the way between England and Australia under steam alone without stopping, and carry passengers by the hundred, to realise the phenomenal developments which have marked the progress of the last fifty years.

Races between steamers fitted with the rival modes of propulsion were not uncommon, but did not always take place with official sanction, though the results were carefully noted. One most exciting race was held by arrangement in the Channel to test the relative capacities of twin-screw and paddle boats in March 1865, the competitors being the twin-screw steamer *Mary Augusta* and the London, Chatham, and Dover Railway Company's new steamer *La France*, said to be the fastest boat in the Channel service. The screw boat left Greenhithe early in the morning and steamed down to Dover to wait the departure of the mail steamer. The latter, when time was taken, was about three cables' length ahead of and on the weather bow of the *Mary Augusta*. The screw drew level, but a hot bearing developed in her starboard engine, necessitating that engine making fewer revolutions and causing her to steer badly. She continued to gain however, her rival, according to a contemporary record, "emitting such immense volumes of steam and smoke from her two funnels as satisfactorily proved that the engines were having more steam than they could make use of, and that *La France* could never at any time or under any circumstances during her yet short career have been driven with more purpose to win than at the present." After the heated bearing was cooled the *Mary Augusta* resumed her full speed and the race was her own from that moment, and she reached Calais Pier three and a half miles ahead. The *Mary Augusta* returned to England at full speed without entering Calais Harbour. The time occupied by her in the double run from Dover to Calais and back was 2 hours 45 minutes 10 seconds, a rate of speed never

equalled by any screw steamer before. She went to the Thames at full speed in a violent north-east gale and was back at Gravesend at a quarter-past nine the same evening.

We will now continue the history of the steam-ship services to the East, Africa, and South America. The P. & O. steamer *Himalaya* has already been mentioned. She was built of iron, was launched at Mare's shipyard at Blackwall in May 1853, and was originally intended to carry paddle-wheels driven by engines of 1200 horse-power, but at an early stage in her construction it was decided that she should be a screw boat. Her engines, by John Penn and Son, were of 700 horse-power. This steamer was 340 feet between perpendiculars and 46 feet 2 inches beam, and of 3550 tons.

One notable steamer the company had was the *Delta*, launched in 1859 by the Thames Iron Works and Shipbuilding Company, and described as the handsomest of her class yet built on the Thames. She was a clipper-bowed vessel, carrying stump bowsprit, had two masts, and was fore and aft schooner-rigged. Her masts and her two funnels raked aft considerably, and gave her the appearance of possessing great speed. She was 350 feet in length over all, with a beam of 35 feet 3 inches. The engines, by Penn of Greenwich, were previously in the *Valetta*, from which they were taken to make room for machinery of less power. The change was of benefit to the *Valetta*, as she did equally well with her new engines. At her trial in Stokes Bay the *Delta* averaged rather more than 14½ knots an hour, stated to be a greater speed than had been attained there by any previous vessel. She was double the tonnage of the *Valetta* and carried 800 tons more coal, and had 1200 tons more displacement. Her engines, of 400 nominal horse-power, gave an indicated horse-power of over 1600.

The company kept abreast of the times in its steam-

THE "DELTA" LEAVING MARSEILLES FOR THE OPENING OF THE SUEZ CANAL.

p. 260

ships, and without displaying any recklessness was not behind in adopting innovations likely to be advantageous. Its experiences with the compound engine were not such, however, as to encourage it to take the lead with new inventions. Its first essay in this direction was in the *Mooltan*, built in 1860, and by 1864 several steamers had been constructed with the new and costly engines.

"But the result was a grave disappointment. The economy was undoubted; but the machinery, although it had been fitted by one of the most eminent firms in the country, regardless of cost, was found to be unreliable. The accidents were numerous, and although comparatively slight, they occurred so frequently that the efficiency of the mail service was in danger of being impaired. The result was that several of the ships thus fitted had these costly engines replaced by less complex machinery, involving the company in serious loss. The *Mooltan* was an example of a vessel fitted with appliances in advance of the age. Not only were her engines of the new type, but she was likewise fitted with hydraulic steering gear and refrigerating machinery; and all these appliances had eventually to be removed, because they could not be relied on to work satisfactorily throughout a long voyage. It was not until 1869 that the company succeeded in building a steamer with high and low pressure machinery which could be considered thoroughly successful." *

The African Steamship Company was incorporated in 1852 to carry out a contract with the British Government for conveying the mails monthly to the principal ports of the west coast of Africa and to Madeira and Teneriffe, and also to establish a line of steamers between Sierra Leone and the West Indies. The contract for the mails was entered into by Mr. Macgregor Laird in December 1851, and was for ten years from the ensuing December, commencing with an annual payment of £23,250 and

* P. & O. Company's Handbook.

diminishing by £500 a year during the continuance of the contract, thus averaging £21,500 per annum.

Five steamers were built for this service by Laird of Birkenhead; they were of iron and were screw-propelled vessels. By 1860 the company was in difficulties and it was proposed to wind it up, but the directors were persuaded to try a service between Liverpool and the west coast of Africa, with excellent results to all concerned for a time, but the control of the company was not too efficient in London and the concern dwindled until, in 1891, it passed into the possession of Elder Dempster and Co., and then progressed even more rapidly than it had previously declined.

The Royal Mail Steam Packet Company, who it will be remembered launched their first steamers in 1841, adopted the screw propeller in 1849 when they launched the *Esk*. They were the first to adopt screw propulsion for the conveyance of mails. The company assisted the Panama Railroad Company in 1850 by lending them 125,000 dollars towards the completion of the railroad across the isthmus, and in January 1851 opened a mail service from Southampton to Brazil and the River Plate. Several of their steamers were chartered as transports during the Crimean War. The *Dee* was chartered in 1860 to the French Government to convey the "Irish Brigade," which had been raised in Ireland to fight for Pope Pius IX. against Garibaldi, from Havre to Cork on their return from Italy.

In the following year the Confederate States commissioners, Messrs. Slidell and Mason, were taken by force in West Indian waters by the Federals from the R.M.S.P. *Trent*. The "*Trent* affair," as the ensuing international crisis was called, ended in January 1862, when the company's *La Plata* arrived at Southampton with the two commissioners on board.

The *Shannon*, one of their steamers, arrived at South-

ampton in August 1864 from the West Indies with a record consignment of specie, consisting of gold and silver to the value of £1,511,426 in 2207 packages, which was transferred to the Bank of England in forty-one waggons. In 1869 the R.M.S.P. transatlantic steamers extended their voyage from Rio de Janeiro to Buenos Ayres, thus avoiding transfer to smaller vessels at Rio de Janeiro; the *Douro* being the steamer inaugurating this extension.

The steam-ship *Victoria*, built of iron in 1852 for the Australian Royal Mail Steam Navigation Company, gained the prize of £500 offered by the colonies for the fastest voyage to Australia. Her time from Gravesend to Adelaide was sixty days, including two days' stay at St. Vincent. She was designed by Messrs. I. K. Brunel and J. Scott Russell for a speed of ten knots under full steam, and to provide as much passenger accommodation and space for high-priced cargo as her coal requirements would permit. She was 261 feet on the water-line and registered 1350 tons. The entrance and run of the ship were of the wave-like form, while the central 45 feet were parallel; the bilges were round, the topsides tumbled home, and there was no external keel, so that she was very heavy in a seaway. The hull was in twelve water-tight compartments, and longitudinal bulkheads were carried through from the engine and boiler rooms so as to separate the coal from the machinery. The engines were of the oscillating type. The ship had four masts and a sail area of 1540 square yards. Under steam alone the engines at full power made 59 revolutions per minute and gave a speed of 11 knots, with a coal consumption of 37 tons per 24 hours. Under sail alone, with the screw held vertically, the speed was $5\frac{1}{2}$ knots, but when the screw was allowed to run freely the speed increased to $7\frac{1}{2}$ knots. Her average speed was nearly $11\frac{3}{4}$ knots.

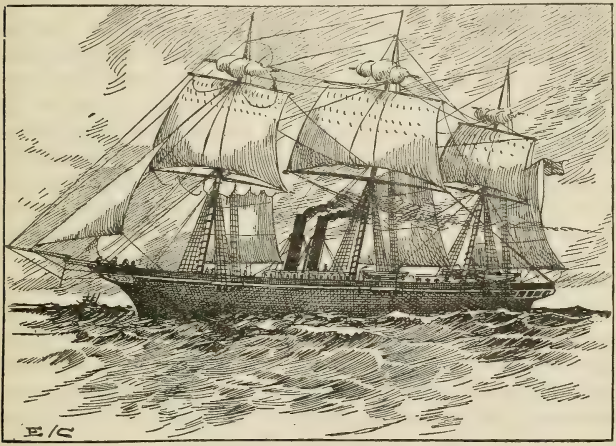
The Pacific Steam Navigation Company's operations were confined to the west coast of South America until

1865, when, in pursuance of a supplemental charter, it extended its sphere to the River Plate. Steamers were specially built for the service, and in 1868, the *Pacific*, after being about three years on the coast, sailed for Liverpool from Valparaiso to inaugurate the new mail service. Six other iron screw vessels were added and the venture proved so profitable that it was determined to make the sailings fortnightly, and the steamers *Chimborazo*, *Aconcagua*, *Garonne*, *Cuzco*, and *Lusitania* were built. All these steamers were afterwards in the Orient Line's service to Australia, together with the *John Elder*, which was one of the earlier batch of boats on the Liverpool–Valparaiso route. Seven more steamers were added in 1871, and by 1873 the number of new vessels totalled eighteen. They were all clipper-bowed barque-rigged steamers and were very handsome craft. After this the company went in for the straight stem and pole-masted type of steamer.

The rivalry in the various over-sea trades was very great, and no sooner did one shipowner secure a vessel which surpassed its competitors than other owners sought to improve upon it. The sailing ships were soon obliged to give way to the steam auxiliary vessels, especially when craft like the *Lightning* appeared. The *Lightning* was built by the Hendersons of Glasgow, and so pleased were her owners, Messrs. Apcar of Calcutta, and their representative, Captain Durham, with her, that he ordered the *Thunder*. The *Thunder* was built by Mr. Lungley at his yard on the Thames and engined by Messrs. Dudgeon, and was an improved edition of her predecessor.

The *Thunder* was launched in December 1859, and soon demonstrated that she was the fastest steamer yet provided with a screw propeller. She was a handsome vessel, ship-rigged, with clipper bows, and her masts and funnels had a slight rake which gave her a very attractive appearance. Her length was 240 feet between perpendiculars, beam 30 feet, depth $22\frac{1}{2}$ feet, and her

tonnage, builder's measurement, was 1062. The engines were of 210 nominal horse-power with cylinders of 55 inches diameter, and a piston stroke of three feet. A peculiarity in her boilers was that they consumed the fuel and heat in furnaces and tubes to the point that the remainder escaped up the chimney and heated the super-



THE "THUNDER."

heater to a temperature of 300 degrees, without regulation. On her trial trip she travelled at the rate of at least seventeen statute miles per hour, and afterwards did even better. Her coal consumption also was the lowest then attained, being about one pound per indicated horse-power per hour. Her screw was of the ordinary type and was placed outside the rudder. The *Lightning* and the *Thunder* were both employed in the China trade.

The first ocean-going screw steam-ship of her class to which the modern double or twin-screw system was

applied was the iron vessel *Far East*, which was launched from Dudgeon's yard, Millwall, towards the close of 1863. She was intended for the China tea trade of the owners of the *Lightning* and *Thunder*. The *Far East* was 227 feet between perpendiculars and 210 feet on the keel; 34 feet beam, 22 feet moulded depth, and 20 feet 6 inches depth of hold; her depth at load water-line was 17 feet, her displacement 2200 tons, and her builder's measurement tonnage 1258 tons. On her upper deck she had a capacious poop and forecastle, and there were deck-house and cabins amidships. Her engines were of 150 nominal horse-power, driving a two-bladed lifting screw under each quarter. The engines had annular combined cylinders, the diameter of the high-pressure cylinder being 24 inches and of the expansive cylinder 50 inches, with a piston stroke of 24 inches. The screws were 8 feet 2 inches in diameter, with a pitch of 16 feet. Each of the two boilers had six furnaces with 109 square feet of firebar surface, and a tube surface of 1883 feet. The shafting of the screws projected through a wrought-iron tube of great strength bolted to a false iron bulkhead clear of the ship's frame. The tube at its outer end was connected with a wrought-iron slide, which guided the screw to the well when being lifted, or to the shafting when being lowered. The screws were raised by a worm and barrel apparatus. The lower and top masts were of iron bolted together through flanges, and the topgallant masts fitted closely into the topmast heads, so that the masts from deck to button looked like immense slender poles. There were no tops, but light iron cross-trees spread the rigging, and preventive top and topgallant backstays were carried far aft of the lower rigging. Her funnel was placed well abaft the main-mast. She was given a full rig on all three masts, and in addition carried fore and main try-sails.

No sooner was she afloat than the double-screw steamer

Pallas was sent into the water from the adjoining slipway; this being the first time on record that two iron twin-screw vessels were launched from the same yard on the same day.

In January 1865 the double twin-screw steam-ship, *Louisa Ann Fanny*, was launched, and as it was thought she might possibly be acquired by the Confederates, the bunkers were so arranged as to afford ample protection for her engines from hostile shot. Her machinery consisted of horizontal direct-acting engines with cylinders of 40 inches diameter, and $22\frac{1}{2}$ inch stroke, driving two three-bladed screws of 9 feet 3 inches diameter and a pitch of 17 feet 3 inches, the distance from centre to centre of the screws being 10 feet 10 inches. She attained, when loaded, a speed estimated at $15\frac{3}{4}$ miles an hour after allowing for the tide.

Want of space has prevented the relation of further details of the steam-ship history of the period, though a few from the long list of steam-ship companies of other countries may be mentioned. The Messageries Maritimes de France grew out of a company formed to carry inland mails. In 1851 they contracted to carry some of the oversea mails, and extending their operations as the years went on are now the largest steam-ship company in France. The next largest French company is the Compagnie Générale Transatlantique, which was formed in 1862 and is also a mail carrier. To this company belong the largest steamers ever constructed in France. The Hamburg-America Company of Germany launched its first steamer, the *Borussia*, in 1855 for the Atlantic service, and the Norddeutscher Lloyd followed in 1856 with the *Bremen*. These boats were, however, built in Great Britain, as all large German steam-ships were until comparatively modern times. The Austrian Lloyd Steam Navigation Company, which belongs to Trieste, was founded as far back as 1836 for the Mediterranean service.

This chapter may be fitly brought to a conclusion with a reference to the *Great Eastern*—the wonder and the failure of her age in popular estimation. To the general public she appeared as an extraordinarily large ship which was a complete failure as a commercial undertaking. To a few she was the embodiment of all that skill and scientific genius had conceived in construction up to that time. She was the great illustration of the longitudinal system of construction invented by Scott Russell, and of the use of longitudinal and transverse bulkheads.

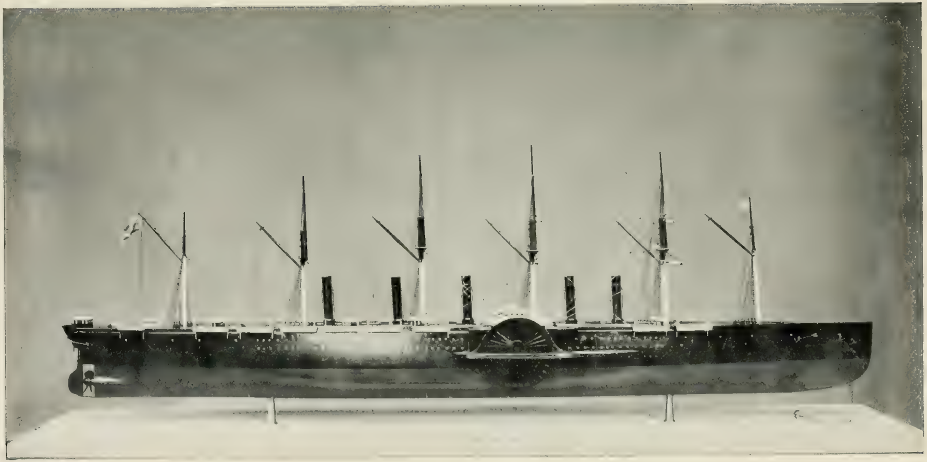
Scott Russell's invention of the longitudinal frame was due to his perception of the fact that as vessels increased in size the longitudinal strain would become greater, especially when they were carrying heavy machinery amidships or nearly so. In the vessels of the size then constructed the longitudinal strain experienced by small iron ships was comparatively small. One method adopted to strengthen hulls longitudinally was to give them a number of floor-plates, forming a strong continuous keelson. Other keelsons were also constructed to run fore and aft near the bilges ; a bilge stringer was added, while on the outside, bilge keels were sometimes fixed. Russell introduced the system in 1835, but the registration societies did not look with approval on the innovation and nothing came of it at the time.

As ships were made larger, however, the nature of the stresses they had to bear became better understood, and precautions had to be taken to prevent the hogging and sagging to which they are subjected by the motion of the sea, besides the lateral and other stresses. In 1835–6 Mr. Russell built three small iron vessels, one of which had a longitudinal middle-line bulkhead and four transverse bulkheads connected by longitudinal stringers and without transverse frames. The other two had no longitudinal bulkheads but were fitted with a greater number of transverse

partitions and stringers. He applied the latter method in 1850 to a small iron screw boat on the Humber, and in her some deep web plates were fastened by angle irons to the shell-plating and were also stiffened with angle irons along the inner edge. The inventor described this arrangement as being ordinary transverse bulkheads with the whole of the centre portion removed. The same year he built an iron paddle-steamer, 145 feet in length by 15 feet beam, and 7 feet 6 inches depth, on the longitudinal principle. Notwithstanding its extraordinary length in proportion to its beam and depth the vessel was a perfect success. One notable vessel constructed on this principle was the *Rhenus*, 197 feet over all, by 25 feet extreme breadth, and 9 feet depth, and drawing only 3 feet of water. These vessels, which were almost experimental in character, were followed by several others of a more highly developed type, such as the *Baron Osy*, a fine and fast paddle-steamer launched in 1855 for the London and Antwerp service. She was strengthened with the partial or open bulkheads of the type already described, which acted as frames, and had broad top stringers under the deck. This vessel had an oscillating condensing engine with two cylinders, and her paddles gave her a speed above that of other vessels on the route. The success achieved by her, both in regard to constructional strength and seaworthiness, had not a little to do with the designing of the *Great Eastern*. Before this, however, in 1852, Scott Russell designed with Brunel, who was consulting engineer to the Australian Royal Mail Steam Navigation Company, two steamers, the *Victoria* and *Adelaide*, on the wave-line principle, but they were not on his longitudinal system though including some of its features. In these vessels he introduced for the first time fore and aft bulkheads amidships combined with a part iron deck. They had an important influence on the adoption of the longitudinal system, as the constructional strength of the

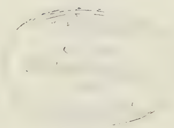
vessels was provided for by the addition of a flat keelson extending almost to the bilges and connected at either side with a longitudinal bulkhead which formed the coal bunkers and rose as high as the main deck, the hull thereby being transformed into a powerful box-girder. The experience derived from these vessels caused them to be the forerunners of the *Great Eastern*, and like her they were a financial failure. They could not carry enough fuel for the voyage, and this and other considerations led Brunel to design the great ship in an attempt to solve the difficulties to which these vessels had directed attention. He estimated that the vessel would be able to attain a speed of 15 knots at a less coal consumption per ton than any steamer in existence. The Eastern Navigation Company was formed in 1851 and decided on the construction of a steamer in accordance with his views. It was proposed to run a line of big steamers to the East, via the Cape of Good Hope, and as the vessels were referred to as Leviathans the name *Leviathan* was chosen for the first (and, as it happened, the last) vessel the company ever owned. This was the *Great Eastern*. The lines of the vessel were designed by Russell, who also built the hull. The details of the ship's construction were settled by Russell and Brunel; the longitudinal system was adopted, together with the bulkhead system, to which Russell attached such importance.

The *Great Eastern* was built with an inner skin from the keel to the water-line, thus being a double-hulled vessel. The inner and outer skins were of the same thickness of iron plates, the bottom plates being one inch thick and the other plates three-quarters of an inch. The space between the two hulls was 34 to 36 inches, and this was estimated to hold 2500 tons of water-ballast if required. The transverse iron bulkheads divided the ship into a number of compartments, each sixty feet long, and in order to add to the strength of the ship and increase her



Model of the "Great Eastern."

p. 270



safety in case of collision, there was no opening in these bulkheads lower than the level of the second deck. For 350 feet of her length the vessel had two longitudinal bulkheads 36 feet apart, beside which there was a second intermediate bulkhead up to the main deck, forming a coal bunker. Five of her six masts were of iron and hollow, and the sixth of wood.

The project of building this enormous ship was received with enthusiasm by the public. Every item of news, correct or otherwise, was welcomed eagerly, and the newspapers vied with each other in the extravagance of their assertions. She had both paddle-wheels and a screw propeller, and it was confidently stated that she would attain a speed of even twenty-five miles an hour, and this, it was thought, might be exceeded if she had a strong favourable wind and used both her mechanical aids. Her size was expected to make her indifferent to the storms of the ocean, and her behaviour at sea was confidently prophesied under all sorts of conditions.

Chambers' Journal published an article in which the powers of the vessel were set forth, and in which it said:

"It has generally been conceived that the ill-fated *President* steam-ship snapped across some Atlantic wave, as a match might be snapped between the fingers; the still more gigantic *Great Western*, *Himalaya*, *Atrato*, and *Persia* have, however, since that unfortunate accident, continued to plough their ways in safety through the ocean storms. The *Great Britain* lay for months among the breakers of the rock-bound coast of Ireland, and yet finally floated off unscathed, to render good service to the British Government as a transport in time of need. The grand experiment of the cyclopean order of naval architecture is, however, in preparation, and shortly to be put to the test. The Great Eastern Steam Navigation Company have for some time been engaged in building an iron ship upon a scale, both as regards absolute dimensions

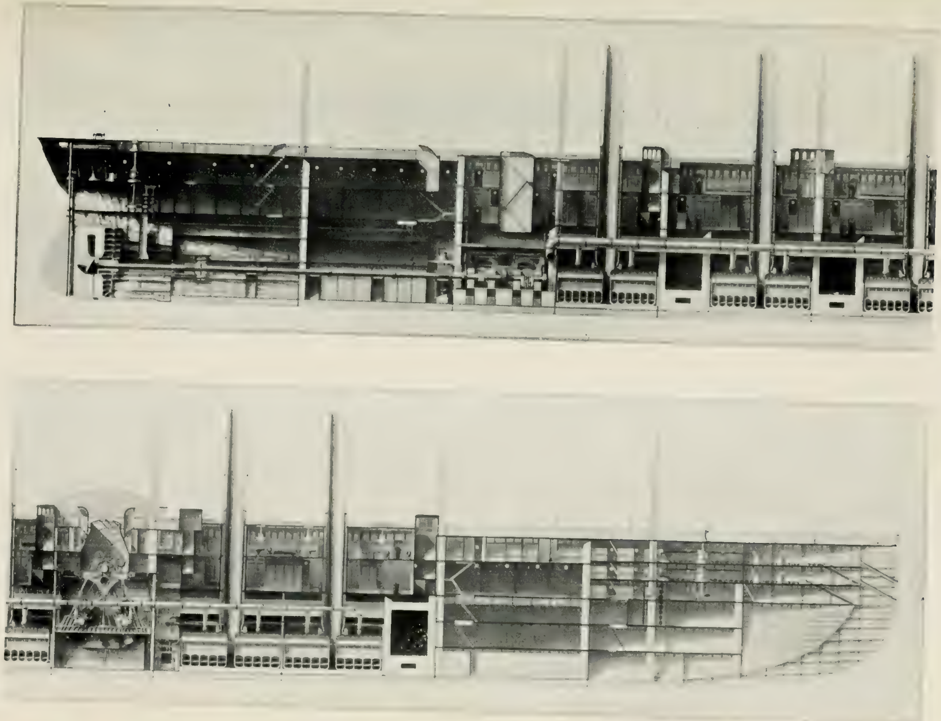
and strength of material, that will at once change all its leviathan predecessors into pigmies.

"The upper deck runs flush and clear from stem to stern for a breadth of about twenty feet on either side, thus affording two magnificent promenades for the passengers just within the bulwarks. These promenades will be each rather more than the eighth part of a mile long. Four turns up and down either of them would exceed a mile by 256 feet. The vessel when launched will be more than as long again as the steam-ship *Great Britain;* it will be nearly three times as long as the line-of-battle ship the *Duke of Wellington*, and nearly as long again as the *Himalaya;* eighty-eight feet more would make it as long again as the *Persia*, at present the longest vessel afloat upon the ocean.

"It is anticipated that this multiplication of internal braces and supports will be sufficient to enable the hollow hull to resist, as a whole, very much more violence and much heavier strains than the elements can ever inflict upon it.

"It is calculated that a sharp long wedge of this kind, impelled by the force of nearly 4000 horses, and extending its length on the water along a distance of nearly 700 feet, will pass through it with the speed of twenty miles an hour. This would be amply sufficient to enable it to make the voyage to India, round the Cape of Good Hope, in thirty days, or to Australia in thirty-three days.

"The anchors alone will weigh 55 tons, and there will be 200 tons of capstans, cables, and warps connected with them. These ponderous implements obviously could not be wielded by human hands, and accordingly steam-sailors will be prepared to do what the flesh-and-blood sailors would not be able to accomplish. There will be journeymen steam-engines stationed conveniently for effecting the anchoring and weighing, and, indeed, for performing many other services ordinarily



Longitudinal Section of the "Great Eastern."

p. 272

carried out by the crew. Possibly there will be steam-steersmen for the guidance of the mass. It is on account of this supplementary and subsidiary steam-service that only 400 men will be needed to work so vast a ship.

"Once again, how will the winds and the waves affect this leviathan mass, when they chance to be in their surly and ungenial moods? A connected mass of 27,000 tons is not as easily heaved as a cork or a cockle-shell; but the storm-winds and the storm-waves of the open ocean have a tremendous power. What will they do then, with this stupendous morsel, when they have it fairly within their clutches? The heaviest hurricane-wind blows with a force that would act upon a square foot of resisting surface with a pressure equivalent to a weight of 40 lb. Such a wind could only heel the leviathan with its full load out of the perpendicular to the extent of six inches even if it struck it quite on the side! The waves of a fresh sea run about 100 feet long. Those of a moderate sea are 300 feet long. Of such the leviathan would take two at once, and would preserve the while almost an even keel. The highest storm-waves ever seen on the wide and deep ocean are only 28 feet high from trough to crest, and 600 feet long from trough to trough. Of course the leviathan would still take two at a time, when the crest of one was near to the bow, and the crest of the other near to the stern. Under the most unfavourable circumstances such waves would not disturb the horizontal equilibrium of the deck line to the extent of more than five degrees. . . . The captain of the leviathan will have a cabin for himself, situated conveniently near the centre of his domains, on the mid-deck, and between the huge paddle-boxes. But placed here like a spider lurking in the centre of its web with outstretched attentive feelers, he will have to use his telescope to see what is going on at the bows and stern; and the old contrivance for issuing orders, the speaking

trumpet, will be altogether out of date and valueless in his hands. His voice, even with this aid, would hardly be heard half-way to the stern. He will have to signal his directions to his officers by semaphore arms by day and by coloured lamps by night. He will also have electric-telegraphs ramifying to the engine-rooms, and to other places to which it may be necessary that his instructions should be instantaneously communicated. The compasses will be placed aloft on a staging reared forty feet above the deck, to remove them from disturbing influences inherent in the vast masses of iron below; and it is proposed that strong shadows of the needles shall be cast from a tube, so that the steersman may at once watch these shadows, and so follow exactly the movements of the compasses as they traverse. It is also proposed to carry a perpetual moonlight diffused around the ship, emanated from an electric light planted on the foremast head.

"Up to the present time £350,000 has been expended upon this wonderful construction, and by the time the vessel is ready for sea, this sum will have been augmented into nearly £800,000. It will, however, be understood that there is a fair capacity in the vast vessel for yielding a revenue ample enough to render the undertaking a commercial success, notwithstanding this great cost, when it is borne in mind that if the fares for a single outward or homeward passage to India or Australia for the three classes be fixed only at £65, £35, and £25 respectively, the passage-money alone for the voyage out and home would amount collectively to something beyond £300,000 if all the berths were occupied. It is an interesting fact that naval engineers fix the amount of tonnage required in a steam vessel designed for any particular voyage by a very simple standard; they consider that one ton of burden is needed for every mile to be traversed; hence it is that this vast steam-ship has been made capable of carrying 25,000 tons. It is intended to go in every

Caricature of the "Great Eastern," from a Contemporary Print.

p. 271

voyage 25,000 miles: it is a distance equal in extent to the circumference of the world.

"It is estimated that this great vessel with 5000 tons of merchandise and her complement of 4400 living beings would still be able to store enough coal for her consumption during a complete circumnavigation or a voyage out and home."

The iron plates used in the construction of her hull weighed 10,000 tons and to fasten them together required three million rivets. Her length was 680 feet, breadth 82½ feet, depth 58 feet, and displacement 27,384 tons. The paddle-engines were of 1000 nominal horse-power and worked up to 3411 ; and weighed no less than 836 tons. The four cylinders weighed when finished 28 tons each, they were 74 inches in diameter and had a stroke of 14 feet. Each of the two right-angle cranks was driven by two cylinders, inclined at a mean angle of 22½ degrees from the vertical. Each paddle-wheel was worked by a complete double-cylinder engine and could be revolved without the other if necessary. Four double-ended tubular box boilers supplied steam for the paddle-engines at 24 lb. pressure. They were each 17½ feet long by 17 feet 9 inches wide, and 13 feet 9 inches high, and had forty furnaces and 4500 square feet of heating surface. Each boiler weighed fifty tons and contained about forty tons of water. Her first paddle-wheels were 56 feet in diameter, but these were damaged in some rough weather, and the next pair, only 50 feet in diameter, were much stronger and equally serviceable in the matter of speed and lasted out the ship. Her calculated speed under both screw and paddles was 15 knots and under the wheels alone seven knots. She certainly never approached the fanciful speeds predicted for her by the newspaper enthusiasts, and it is only fair to her builders and designers to say that these prophecies did not originate with them.

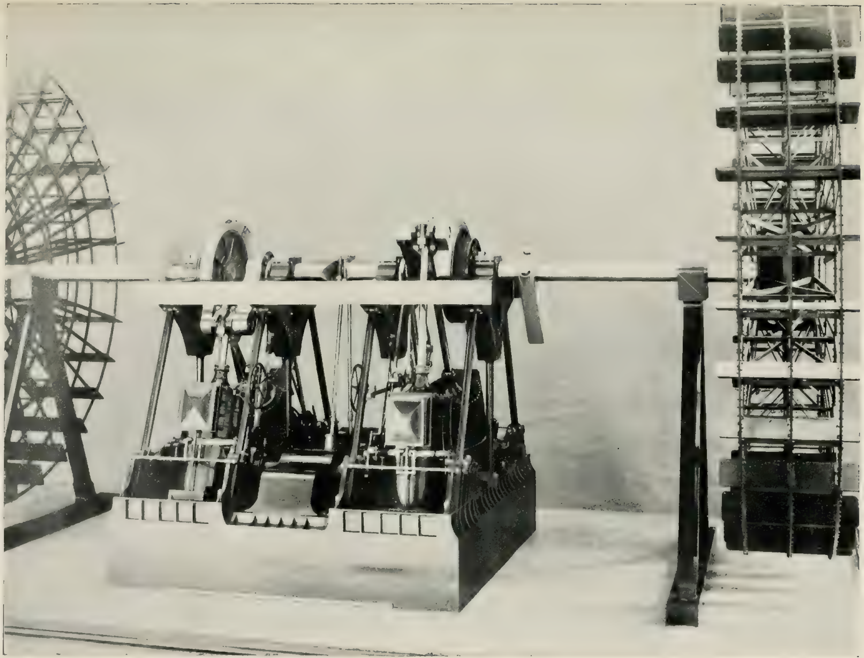
The engines for the screw propeller by James Watt

and Co. were horizontal and direct-acting, and were of 1800 nominal horse-power and 4886 horse-power indicated. They weighed 500 tons. Six double-ended tubular rectangular boilers gave steam at 25 lb. pressure. The propeller was a four-bladed cast-iron screw 36 tons in weight, and of 24 feet diameter and 44 feet pitch. The shaft of the propeller weighed 60 tons and was 150 feet in length. So as not to interfere with her speed when the screw should not be working, two small auxiliary engines were fitted to keep it revolving when disconnected from the main engines. Her speed under the screw alone was about nine knots.

Her longitudinal bulkheads were carried to the uppermost deck, which was perfectly flush and extended from one end of the ship to the other. An iron deck connected the head of each longitudinal bulkhead with the ship's sides and this, being at the greatest possible distance from the bottom of the girder, was in a position to contribute most to the longitudinal strength. The Britannia Bridge over the Menai Straits has its top and bottom flanges of cellular construction, and Brunel practically repeated this formation in the *Great Eastern*, by making both the bottom and the upper deck cellular.

The launch of the *Great Eastern* was arranged for November 3, 1857, and it was not till then that it became known that this was to be the vessel's name and not *Leviathan*. The vessel moved only a few feet and then stuck. One of the causes of the hitch was that the ship was being launched sideways, thereby greatly adding to the difficulties of the operation. Another attempt a few days later did not move her an inch. On January 11 she was got a little nearer the water and the next day was moved a little farther ; she was finally launched at the next spring tides at the end of the month.

" It is incomprehensible how so eminent an engineer as Brunel should have made such a mistake as to attempt



Model of the Paddle-Engines of the "Great Eastern."

p. 276

to force so huge a fabric broadside-on into the river. The costly experiment added £120,000 to the cost of the ship, and practically ruined the company." *

As the company had not the money to finish her, it was wound up and the ship was sold to another company, formed to take her over, the price being £160,000. It was necessary to raise another £300,000, and as the financiers would not find the money, the public was appealed to and responded to the extent of £50,000 from some of the humblest classes in the community, "without any expectation of profit, but solely that they might hear of the great ship, which they looked upon as the pride of England, being fairly afloat on the deep waters." †

Her first trial trip took place in September 1859 and was marred by an explosion which killed six men, wounded several others, and wrecked the saloon. She was designed to carry 800 first-class passengers, 2000 second-class, and 800 third-class, or 10,000 troops, it being expected that the Government would utilise her as a troopship. Her first voyage was made, not to India, to which she never went, but to New York, to which she took 36 passengers. She left Southampton on June 17, 1860, and arrived on June 28, all New York turning out to see her. Her best day's run was 333 miles, and at no time did she exceed 14½ knots an hour. On her homeward voyage she did rather better, as she carried 212 passengers and a large cargo in a passage of 9 days 11 hours. Her one experience as a trooper was when she took 2125 soldiers to Canada at the time of the *Trent* affair. On her next outward voyage she met with a gale in which her steering gear was rendered useless and she was nearly lost. In 1865 she was engaged in laying the Atlantic cables. She was employed in this kind of work for some years, off and on, until in 1886 she was acquired

* Kennedy's "History of Steam Navigation."

† *Illustrated London News*, August 13, 1859.

by an enterprising drapery and tea firm and used as a show-place and advertisement. In 1890 she was sold to be broken up, and thus disposed of in small lots at little better than old iron prices. The *Great Eastern* was an unlucky ship from start to finish. From the bankruptcy of Mr. Scott Russell some time before she was launched until she was left to rust on a Mersey mud-bank, almost every one concerned with her had a share of her misfortune. The one task in which she acquitted herself well was the Atlantic cable-laying.

But her significance in the history of steam-ship construction must not be under-estimated. Sir William H. White's opinion on this point was given in his address to the Institution of Civil Engineers, in 1903, as follows; "Having recently gone again most carefully through Brunel's notes and reports, my admiration for the remarkable grasp and foresight therein displayed has been greatly increased. In regard to the provision of ample structural strength with a minimum of weight; the increase of safety by water-tight subdivision and cellular double bottom; the design of propelling machinery and boilers, with a view to economy of coal and great endurance for long-distance steaming; the selection of forms and dimensions likely to minimise resistance and favour good behaviour at sea; and to other features of the design which need not be specified, Brunel displayed a knowledge of principles such as no other ship-designer of that time seems to have possessed, and in most of these features his intentions were realised. To him large dimensions caused no fear. 'The use of iron,' he remarks, 'removes all difficulty in the construction,' and experience of several years has proved that size in a ship is an element of speed, strength, and safety, and of greater relative economy, instead of a disadvantage, and that it is limited only by the extent of demand for freight, and by the circumstances of the ports to be frequented."

CHAPTER X

THE BUILDING OF STEEL SHIPS

AS early as 1853 mild cast steel had been suggested for shipbuilding, and in 1855 Howell introduced it as "homogeneous metal," but shipbuilders took little notice of the suggestion for some years. Robert Napier and Sons received orders in 1858 for some high-pressure boilers and marine machinery where lightness combined with strength was of the utmost importance, and it was proposed to use "homogeneous metal" for the one and puddled steel for the other instead of the wrought iron which was ordinarily employed. Steel as then made was very brittle and many attempts were made to remedy this defect. David Kirkaldy made a series of important experiments which lasted three and a half years and attracted the attention of the Scottish Shipbuilders' Association. His principal service was the discovery and placing on record of the effects of oil hardening upon the properties of steel.

The *Ma Robert* is said to have been the first steel steamer ever built; she was constructed by Laird's for the Livingstone expedition to the Zambesi. High tensile steel was used with a limit of elasticity of about twenty-three tons, which is very similar to the metal used in the *Mauretania* and *Lusitania* where stresses are to be met.

Strength and lightness were essential in the *Ma Robert* and therefore the new material was used. The little vessel was 73 feet long, 8 feet wide, and 3 feet deep, and was flat-bottomed and of very little draft. But the hull corroded badly and leaked very much, and the steamer came to grief on a sandbank in the Zambesi.

The *Rainbow*, built of steel plates in 1858, was a smart, handsome paddle-boat, schooner-rigged, and carrying two very tall masts. She had a high-pressure engine and her steam-pipe emitted the energetic snort which was peculiar to the locomotive of the time. Indeed her high-pressure machinery made such a noise that she could be heard from one side of the Mersey to the other. She was intended for the Niger Exploration expedition, and on her trial attained a speed of between twelve and thirteen miles an hour. She was 130 feet long by 16 feet beam. Although her plates were only one-eighth of an inch thick she had the stiffness and rigidity of a strong ship, and there was almost an entire absence of vibration from the engines. Her boilers, which were of puddled steel plates, were proved up to 200 lb. on the square inch, though they were only worked at 50 to 60 lb. The engine was of 60 nominal horse-power, working up to 200 indicated. The hull was divided athwartship and longitudinally by bulkheads into ten or twelve water-tight compartments.

It must be remembered that these experimental steel boats were intended for inland navigation, and being taken to Africa were withdrawn from the observation of practically every one who was competent to judge of the relative merits of iron and steel. Certainly no one attempted to build a steel boat for the ocean for some years afterwards, and it was not until 1875, when the Admiralty, acting upon observations made in the dockyards of France where steel was being used, represented to British manufacturers the importance of improving the quality of steel, that the Siemens-Martin process was

THE "BRITANNIC" (WHITE STAR LINE, 1874).

THE "UMBRIA" AND "ETRURIA" (CUNARD).

p. 280

brought out, and in consequence two cruisers were constructed of steel produced in this way.

With the launching of the *Rotomahana*, an ocean steel steamer of 1777 tons gross built by W. Denny and Bros. in 1879 for the Union Steamship Company of New Zealand, the iron age of the steamer may be said to close and the age of steel to begin. It has been shown how iron slowly but surely replaced wood in construction; when the superiority of steel to either had been practically demonstrated the change from iron to steel was rapid. In 1891 over 80 per cent. of the steam-ships under construction were of steel.

The *Rotomahana* was followed in 1881 in the transatlantic trade by the Allan liner *Buenos Ayrean*. The Allan Line has always been to the fore in the provision of first-class steamers. They were the first to have a steel ocean steamer; the first to adopt bilge keels on vessels, the *Parisian* in 1884 being fitted with them; and they were the first to make the experiment with turbine-driven steamers for ocean traffic in the *Victorian* and *Virginian* in 1903. These two vessels are 540 feet in length by 60 feet in breadth, and 40 feet 6 inches in depth. They are of 12,000 tons register, and have a speed of 17 knots. Besides these, the company has five twin-screw boats of tonnages ranging from 9000 to 11,000 tons, and twenty-two screw boats from 3000 to 5395 tons.

The Cunard Line's first steel steamer was the *Servia*, built by Messrs. J. and G. Thomson, and completed in 1881. She was 515 feet in length, and of 7392 gross tonnage, and her engines, of 10,000 indicated horse-power, gave her a speed of 17 knots. Incandescent electric lamps were fitted in her, she being the first of the fleet to carry them. The *Aurania*, of slightly less length, but of equal speed, and also of steel, was built in 1883. After her came the *Umbria* and *Etruria*, steel single-screw steamers, with engines of 14,500 indicated horse-power,

giving them a speed of 20 knots. The sisters *Campania* and *Lucania*, steel twin-screw vessels of 12,952 tons, were added for the New York trade, and later the *Caronia* and *Carmania*. They were sisters except in their engines; the latter being the company's first turbine experiment, and having triple propellers. They are each 675 feet in length by 72 feet 6 inches beam, and 43 feet 9 inches moulded depth.

The *Etruria* was sold in 1909 to the shipbreakers for £16,750, and with her there ended another chapter in the history of the navigation of the North Atlantic. She was a "flyer" only a few years before being disposed of, her record passage from Queenstown to New York being 5 days 20 hours 55 minutes, and her eastward passage 6 days 37 minutes. She was built to outstrip the *Oregon*, a vessel built for the Guion Line in 1883 by John Elder and Co., and known from her speed of 18 knots as "the greyhound of the Atlantic." The same builders were ordered by the Cunard Company to eclipse her, and constructed two steamers, the *Etruria* and *Umbria*, which for many years were the fastest ships afloat. Before they left the builders' hands, however, the *Oregon* was acquired by the Cunard Company. The two Cunarders had the largest compound engines in existence. These boats were 500 feet between perpendiculars, 57 feet 3 inches beam, and 40 feet moulded depth. They were each of 8127 tons gross, and had engines of 14,500 indicated horse-power, giving them an average speed of 19 knots. It was stated of them at one of the meetings of the Cunard Company that "no ships ever gave their owners less uneasiness than these two, and no ships have done such an extraordinary amount of good work. They are monuments that cannot lie to the skill of the design and the faithfulness of the labour that went to their accomplishment."

The Cunard express steamer *Mauretania*, sister ship to the *Lusitania*, launched at Clydebank, was constructed on

THE "MAURETANIA" (CUNARD, 1907).

THE "CAMPANIA" (CUNARD, 1892).

p. 282

the Tyne by Messrs. Swan, Hunter, and Wigham Richardson, Ltd., who were already represented in the Cunard fleet by the *Ultonia*, *Ivernia*, and *Carpathia*. A description of the *Mauretania* given by the builders and the Cunard Company states that the flat keel-plate is five feet wide and three and three-quarter inches thick, and forms a portion of the bottom of the ship. Associated with this flat keel is a vertical keel, five feet high and one inch thick, and to this vertebra are attached, directly or indirectly, the frames and beams which make up the skeleton. The double bottom is divided by this vertical keel and the transverse frames into compartments in which water-ballast may be taken. The tops of these tanks are carried well round the turn of the bilge, so that should the bilge keels be torn away and the hull pierced, the entering water would be confined between the inner and outer bottoms. As a further precaution towards securing insubmersibility, the lower deck is made completely water-tight. Below it are the orlop and lower orlop decks, and above are the main, upper, shelter, promenade, upper promenade, and boat decks—nine decks in all. Automatically closing water-tight doors are fitted in the bulkheads, and can be closed from the navigating bridge in a few seconds. The *Mauretania* has 175 water-tight compartments, so that it is claimed for her that she is as unsinkable as a ship can be.

"The steel plates which cover the ribs or framing of the vessel or are used for the decks, bulkheads, and casings, or in other ways, number 26,000, the largest being about 48 feet in length, and weighing from four to five tons. To secure these plates to each other and the structural framework of the ship, over 4,000,000 rivets have been used, aggregating in weight about 500 tons. The largest rivets are used in the keel-plate, and these are eight inches in length and weigh $2\frac{3}{4}$ lb. The main frames and beams placed end to end would extend thirty miles;

the rudder, which has two sets of steering gear, both of which are below the water-line, weighs 65 tons, and the diameter of the rudder stock is 26 inches. The castings for the stem, stern-post, shaft bracket and rudder together weigh 280 tons. Her ground gear is, with that manufactured for her sister ship, the *Lusitania*, the strongest yet made. The three anchors each weigh ten tons, while the 1800 feet of cable is composed of 24-inch links, the iron in which is $3\frac{3}{4}$ inches in diameter and the weight of each link about $1\frac{1}{2}$ cwts. This mighty harness has been vigorously tested, sample links and shackles emerging successfully from a test strain of 370 tons.

"The principal measurements of the *Mauretania* are:

Length	790 feet.
Breadth	88 ,,
Depth (moulded)	60 ,,
Gross tonnage	32,500 tons.
Displacement tonnage	45,000 ,,
Load draught	37 ft. 6 ins.
Height of funnels	155 feet.
Diameter of funnels	24 ,,
Height of masts	216 ,,

"Figures, however, convey but a bare idea of the great size. A favourite standard of comparison in shipping is the leviathan of Brunel, the *Great Eastern*, the mammoth steamer, which, born before its time, yet solved in her construction many of the most difficult problems with which the modern builders of big ships have to grapple; yet the *Mauretania* quite dwarfs the gigantic *Great Eastern*, as the following figures show:

	Great Eastern.	*Mauretania.*
Length . .	692 feet.	790 feet.
Breadth . .	80 ,,	88 ,,
Displacement .	27,000 tons.	45,000 tons.
	Paddle, screw, and sail.	Quadruple screws.
Speed . .	13 to 14 knots.	25 knots.

"The *Great Eastern* was an experiment, but there is nothing of the experiment about the *Mauretania* and her sister, the Clyde-built ship *Lusitania*. The valuable data obtained from the running of the 20,000-ton turbine Cunarder *Carmania* has afforded a valuable object-lesson in adapting the turbine method of propulsion to liners of the leviathan class, demonstrating the suitability of the steam turbine to the largest type of vessel.

"The *Mauretania* is propelled by turbine engines of about 70,000 indicated horse-power, driving four shafts, each of which is fitted with one three-bladed propeller of manganese bronze. The outermost shafts are each connected with a high-pressure turbine, the inner shafts being rotated by the low-pressure turbines.

"The boilers and turbine engines of the *Mauretania* were constructed by the Wallsend Slipway and Engineering Company, Ltd., of Wallsend-on-Tyne. There are twenty-three double-ended and two single-ended boilers, and one hundred and ninety-two large furnaces. The boiler plates are the largest yet made. The steam is conducted from the boilers into the turbines, of which there are four." The turbines contain about 3,000,000 blades, rotating four shafts, the united length of which is close upon 1000 feet with a weight of about 250 tons, each shaft carrying 17,000 or 18,000 indicated horse-power. Under the covenant with the Government made at the time she was arranged to be built, she is fitted for an armament of 12 six-inch guns. Her rudder and both sets of steering-gear are below the water-line, and in the way of the engine and boiler rooms there are side bunkers which, filled with coal, are equivalent to an armour-belt round the vulnerable portion of the ship.

Although the *Mauretania* and *Lusitania* are usually spoken of as sisters, there are some differences in the design. They are the same length, but the former is six inches deeper, which adds about 500 tons to her

registered tonnage. Special high tensile steel was used to a greater extent in the construction of the *Mauretania*, making that vessel something like 1000 tons lighter. Her lines are slightly finer, and it has been claimed to account for her speed that there is some superiority in her engines.

In regard to the structure of the *Lusitania*, it is stated that with the whole structure of mild steel Lloyd's accepted a stress of ten tons to the square inch, and that in view of the strains thrown upon the upper works a high tensile steel of less scantling was adopted for those parts ; a material having been discovered with a tensile strength 20 per cent. greater than mild steel, a reduction of 6 per cent. in the scantlings was allowed from those for mild steel. The Cunarders were not the first vessels by many years in which high tensile steel of a strength of thirty-six tons was used, as it was introduced twenty-three years ago in the steam-ship *America*.

Whether the great Cunarders pay in the financial sense is known only to the management of the line, but there is no denying that they are a great national asset. A detailed estimate, published at the time they were about to make their first voyages, placed the expenditure at £17,990 per voyage, and the income, allowing for a full passenger list, at £31,350.* But this did not profess to be more than a general estimate and in no sense official. The question has been raised in various quarters whether an equal speed could not have been obtained from reciprocating engines with a less consumption of coal; as a reply to this view it has been pointed out that the sizes that would have been required for the ingots, &c., for the machinery were beyond the capabilities of our steel manufacturers, and thus, as so often has happened, the new set of conditions was met by the new development of invention.

* *Liverpool Courier,* November 18, 1907.

	Campania.	Oceanic.	Baltic.	Kaiser Wilhelm II.	Lusitania.
Displacement	20,000	26,100	33,000	26,000	41,500
Draught .	30	30	30	30	32
Speed .	22	20	$16\frac{1}{2}$	$23\frac{1}{2}$	25
I.H.P. .	30,000	29,000	16,000	38/40,000	65,000
Consumption of coal, tons per day .	485	400	260	660	840
Length, b.p. .	598	685	709	684	760
Breadth .	65	68·3	75·6	72·3	88
Depth .	43	49	49	52·6	60·5
Gross tonnage	12,950	17,274	23,800	19,360	28,830
Number of boilers	13	16	8	12 double 7 single	24
Total cost .	£615,000	£739,000	£800,000	£927,200	£1,250,000

"The above table shows at a glance the ships that have come between the *Campania* and the *Lusitania.* The *Baltic* shows the type of steamer that pays the best, going across at a moderate speed sufficient for most people while at the same time carrying an enormous amount of cargo." *

Alterations have been made in the propellers of both these steamers with a view to finding the size, pitch, number of blades, material, weight, and number of revolutions per minute and the other details upon which efficiency depends, but the result is carefully guarded. Such tests are expensive.

In 1889 the White Star Company built the *Teutonic* of 10,000 tons, which, like her sister ship the *Majestic*, was intended to be an armed mercantile cruiser. These two vessels, which each took nearly three years in building, were at that time the finest the world had seen, and the speediest, and were regarded with such wonder that at the naval review in 1889, one of them was visited by the German Emperor and the late King Edward (then Prince of Wales) and many distinguished officers of the Navy.

* *Shipping World*, January 2, 1907.

The *Majestic* soon brought the record from Queenstown to New York down to 5 days 18 hours 18 minutes, but this was reduced by the *Teutonic* to 5 days 16½ hours.

The second *Oceanic*, also of steel and a twin-screw boat, was placed in the Liverpool and New York service in 1899. She was 704 feet in length and was the first vessel to be built longer than the *Great Eastern*, but in other respects she was smaller, her beam being 68·3 feet, her gross tonnage 16,900 and her displacement tonnage 26,100. The indicated horse-power of the *Oceanic* was 29,000 as against the 11,000 of the *Great Eastern*, and her speed was 21½ knots as compared with 13. In equipment, too, she was regarded as the last possible word in luxury and magnificence. Her promenade deck was 400 feet long, and the saloon was 80 by 64 feet, the latter surmounted by a glass dome 21 feet square.

Two enormous steamers, the *Celtic* in 1901 and the *Cedric* in 1902, of 20,904 tons gross, again established a record for size; the latter is slightly the larger vessel, but in other respects they are sisters. These were the last vessels built for the White Star Line as an independent organisation, as in the following year the line became a part of the great Morgan Combine though still retaining its individuality of management.

The *Republic*, a White Star steamer which had just left New York for England, was rammed off Nantucket in January 1909 by the Italian Lloyd steamer *Florida* inward bound. The White Star liner *Baltic* took off from the *Florida* all the passengers that had been saved from the *Republic*. The latter vessel was kept afloat all night by her water-tight compartments. All the while she was afloat shs ignalled by wireless telegraphy for assistance and this brought the *Baltic* and other vessels on the scene. The *Republic* was built in 1903 for the Boston–Liverpool trade of the Dominion Line and was named the *Columbus*, and was afterwards taken over by the White Star. She was

THE "TEUTONIC" AND "MAJESTIC" (WHITE STAR LINE, 1889).

THE "OLYMPIC" (WHITE STAR LINE, 1910). FROM THE PAINTING BY CHARLES DIXON.

p. 288

a twin-screw steel steamer of 15,378 tons gross, and the largest vessel which has yet been lost at sea.

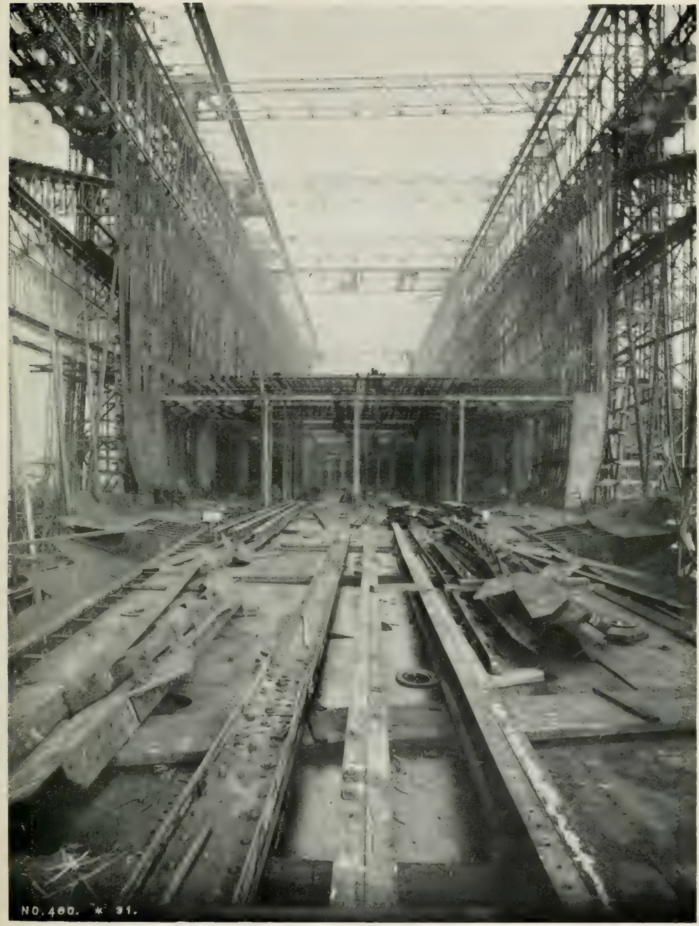
A notable event in the trade with Canada was the introduction of the White Star liners *Megantic* and *Laurentic*, which are run as White Star–Dominion Line steamers to save possible complications with other lines in the Canadian trade. They are important, not only on account of their size, but also because of the engineering experiments they embody, the *Megantic* standing for the highest perfection of the twin-screw balanced reciprocating engine, while the *Laurentic* is remarkable for the introduction of reciprocating engines and low-pressure turbines. In other respects they are sister ships. They are the largest vessels yet placed in the Canadian trade. The *Laurentic* was launched in September 1908 at Belfast by Messrs. Harland and Wolff, and the *Megantic* left the slips the following December. They are each 565 feet long by 67 feet 4 inches beam, and about 15,000 tons gross. Each carries 260 first-class passengers, 420 second-class, and over 1000 in the third class. Their cargo capacity is also very great. They are singled-funnelled, two-masted steamers. Like all the other vessels of the White Star Line they have been constructed throughout on the most approved principles, nothing that long experience and practical knowledge could suggest being wanting to make them as perfect as possible in all particulars.

The last three or four years have seen the advent of the largest steamers afloat, and before the end of 1910 they will be eclipsed by one of the two steamers, the *Olympic* and the *Titanic*, now building for the White Star Line by Harland and Wolff at Belfast, which are to be of about 45,000 tons each. At present the largest White Star vessel is the *Adriatic*, launched in September 1906 and placed upon the service to New York in the spring of 1908. This gigantic ship is 709 feet 2 inches in length, 75 feet 6 inches beam, and 52 feet deep, and her displacement is over 40,000 tons.

Besides the usual luxurious fittings of the vessel, which are all in accordance with the traditions of the White Star Line—she is in this respect an improved version of all her great predecessors—she has an electric passenger lift giving communication between the various decks, a gymnasium, and a full set of turkish baths besides plunge bath, massage couches, and electric baths. The hull is divided into twelve water-tight compartments, the bulkheads being fitted with doors which can all be closed instantaneously from the bridge if desired, and there are no fewer than nine steel decks.

The Inman and International liners *City of New York* and *City of Paris*, steel twin-screw steamers, were launched in 1888 and 1889. These two steamers marked one of those epochs of complete transformation in type of vessel necessitated by the public demands and rendered possible by the advance of engineering science.* They had considerable beam and their subdivison into water-tight compartments was more thorough than in any vessel hitherto built. Another innovation in their construction was the arrangement of fore and aft bulkheads in addition to the transverse bulkheads. Both these ships were of the Inman type with clipper bows and the usual long graceful lines, but they spread less sail than any of their predecessors, being fitted simply with three pole masts carrying fore and aft schooner rig only. The funnels of each boat, which were three in number, were placed between the fore and main masts. Each vessel carried two separate engines built on the three-crank system, and the boilers were constructed to work at the then unusual pressure of 150 lb. to the inch. The rudder was in many respects different from that usually constructed for merchant steamers, and more nearly approximated to the type adopted in the Navy, in which, as a protection against hostile projectiles,

* "The Atlantic Ferry."



THE "OLYMPIC" BUILDING, OCTOBER 18, 1909 (WHITE STAR LINE). p. 290

the rudder is wholly submerged. This form of rudder was introduced in these two steamships as they were intended to be used as auxiliary cruisers. The rudder itself was constructed on a modification of the balanced system, in which a portion of the rudder is placed forward of the stock. Both these steam-ships made some very rapid passages, the *City of Paris* in May 1889 bringing down the time of the transatlantic journey to less than six days. These were the last vessels added to the Inman and International Line. In March 1893 the line was re-organised and became the American Line. This company launched the *St. Louis* and *St. Paul* built at Cramp's yard at Philadelphia. The two American-built ships were each 554 feet in length and of 11,600 tons gross register. They held the record for the New York–Southampton service for some years. During the Spanish-American War they were used as auxiliary cruisers.

The increase in the size of steam-ships is not confined to the Atlantic alone, but is a feature of all the great lines whatever part of the world they may serve. The Peninsular and Oriental, the Pacific Steam Navigation Company, the Ellerman Lines, all the passenger lines trading to North America, the Royal Mail Steam Packet Company, the Orient Line and the principal lines trading to the Far East, are all the possessors of steamers of 12,000 tons or over, though in the case of those that use the Suez Canal the size is limited by the fact that if they were made any larger they might have difficulty in getting through the canal at all. The heavy canal dues, which are already a serious item to the owners of all steamers using the canal, would be more onerous still if the vessels were of greater size, and as it is, some of the lines trading to Australia deliberately take the Cape route so as to avoid this expense.

Lloyd's Register's Annual Summary issued in January

1910 contains the following on the production of large steamers since 1893:

"The number of large steamers launched in the United Kingdom during 1909 has been less than during any of the previous four years. During the years 1893–6, on an average, ten vessels of 6000 tons and upwards were launched per annum in the United Kingdom; in the following four years, 1897–1900, the average rose to 32, at which figure it stood for the four years 1901–4, and at 30 for the four years 1905–8. During 1909 only 19 such vessels were launched. Of vessels of 10,000 tons and upwards only three were launched in the four years 1893–6; 24 were launched during the four years 1897–1900; 27 were launched during the four years 1901–4, and a similar number during the four years 1905–8.

"During 1909 six vessels of 10,000 tons and above were launched, the names of which are as follows:

Balmoral Castle	13,000 tons gross.
Orvieto	12,130 " "
Osterley	12,129 " "
Otranto	12,124 " "
Mantua	10,885 " "
Ruahine	10,758 " "

"At the present time there are under construction 37 vessels of 6000 tons and upwards, of which eight are of over 10,000 tons each.

"The average tonnage of steamers launched in the United Kingdom during 1909 is 2092 tons: but if steamers of less than 500 tons be excluded the average of the remaining steamers reaches 3080 tons gross.

"Of the vessels launched in the United Kingdom 16 are capable of a speed of 17 knots and above. The fastest of these vessels is the turbine yacht *Winchester* (26 knots). The fastest merchant vessels are five steamers intended for Channel service (two turbine and

three twin-screw vessels), all of which attain the high speed of 22 knots."

Of late years the P. & O. Company has added several magnificent vessels to its fleet, of a size and degree of equipment superior to any of their predecessors, mostly of the "M" class, so called because all their names begin with that letter. These are *Moldavia*, *Mongolia*, *Macedonia*, *Marmora*, *Mooltan*, *Morea*, and *Malwa*, and they mark a new epoch in the history of the company's shipbuilding operations, as they far exceed in size the largest previous type as represented by the *China*, *Persia*, *Egypt*, and others, which in their turn were far ahead of all the steamers before them.

The *Marmora* and *Macedonia*, built at Belfast by Messrs. Harland and Wolff, are each of 10,500 tons, and are 530 feet long by 60 feet broad, with a moulded depth of 37 feet. Accommodation is provided for 377 first and 187 second saloon passengers. The *Moldavia* and *Mongolia*, built at Greenock by Messrs. Caird and Co., have a gross register of about 10,000 tons, and are 520 feet long by 58 feet broad and 33 feet deep. They have been fitted for the conveyance of 348 first and 166 second saloon passengers. The arrangements in connection with the passenger accommodation are in advance of anything hitherto attained in the company's steamers in respect to comfort, roominess, light, and ventilation. All the cabins are on the main, spar, hurricane, and boat decks, and most of the inside ones are lighted from the outside of the ship by a passage-way to the scuttle.

The vessels have a coal capacity of 2000 tons in bunkers and reserves, and have a limited cargo space of about 3500 tons, half this space being fitted with the most up-to-date appliances for the conveyance of refrigerated produce.

The fifth of this class of steamers, the *Mooltan*, was built by Messrs. Caird and Co., Greenock.

The *Morea* and *Malwa* combined the best features of all these steam-ships. They are of 11,000 tons register, with engines of 15,000 indicated horse-power driving twin screws, giving them a speed of 18 knots. The former was built by Messrs. Barclay, Curle and Co., being the largest which has yet left their yards. This shipbuilding firm, by the way, claims to be the oldest on the Upper Clyde, and has probably built and engined first-class mail steamers for as many companies as any other shipbuilding establishment in existence. The *Malwa* was built by Caird and Co.

It is thirty-eight years since Barclay, Curle and Co. began building for the P. & O. line, their first steamer being the *Zambesi* in 1873.

It is now some years since steel-built vessels propelled by new and economical machinery became the premier cargo carriers in the Australian trade. Recognising that it would no longer be profitable to build sailers to compete against the steam-ships, many of the sailing-ship owners decided to adopt steam-power and to dispose of their sailing ships as the opportunity offered. The principal steamer lines which brought about this change were the Peninsular and Oriental Steamship Company and the Orient Line. The steam-ships of the Orient Line began to run in June 1877, when the *Lusitania*, chartered from the Pacific Steam Navigation Company, was despatched from London to Adelaide, Melbourne, and Sydney via the Cape of Good Hope. In the following year the joint efforts of Messrs. Anderson, Anderson and Co. and Messrs. F. Green and Co. founded the Orient Steam Navigation Company. The service at first was to be monthly, but it was soon evident that fortnightly sailings were imperative to meet the demands upon the line by shippers and passengers. The fortnightly service was determined upon in the beginning of 1880, the company obtaining the co-operation of the Pacific Steam Navigation Company.

The "St. Louis" (American Line).

The "Morea" (P. & O. Line).

p. 294

Among the earlier vessels were the *Cuzco, Garonne, Chimborazo, Cotopaxi, Lusitania,* and *Sorata,* which were some of the finest that had ever crossed to Australia. The Orient Company afterwards built the steam-ship *Orient,* an iron vessel, and at that time the largest and finest steam-ship afloat. She remained in active service for no less than thirty years, and was disposed of to be broken up only a few months ago, when she was still as sound as on the day she was launched, her only defect being that she was unequal to modern requirements. The Orient Company also built the *Austral,* which had the misfortune to sink in Sydney Harbour whilst coaling. She was raised again and continued in active service until a few years ago. The Orient Company for some years carried the mails to Australia with vessels the ownership of which was shared by the founders of the line, Messrs. Anderson, Anderson and Co., and Messrs. R. and H. Green and Co. and the Pacific Steam Navigation Company, the line being then known as the Orient-Pacific Line. The Royal Mail Steam Packet Company bought out the Pacific Steam Navigation Company and for some years the line was known as the Orient Royal Line. The Orient proprietary, however, recently bought out the Royal Mail Steam Packet Company, and the Orient Company are now the exclusive owners of the service. New vessels have from time to time been added to the fleet, all of which are of steel and propelled by twin screws.

When the Government of the Australian Commonwealth entered into a fresh contract with the Orient Company in 1908, for the conveyance of the mails, for a subsidy of £170,000 per annum until 1920, the company placed orders for the building of five new splendidly fitted steam-ships which are among the largest and fastest travelling to Australia. On the Orient mail route to Australia eleven ports are visited between London and Brisbane, and the journey is thus relieved of the

monotony and tedium usually incidental to a long sea voyage. Notwithstanding the many calls made, the voyage to Sydney is made in 43 days, or in 33 days if the railway is made full use of.

Messrs. Geo. Thompson's Aberdeen Line of steamers is a direct descendant of one of the most famous of the clipper lines. At one time it owned about 25 sailers of the highest class, including the *Thermopylæ*, *Patriarch*, and *Miltiades;* the first named made the fastest passage on record for a sailing ship to Australia, 60 days from London to Melbourne, and with the others afterwards distinguished herself in the tea races. Such was the speed and reputation of the Aberdeen Line clippers that the company did not find it necessary to adopt steam until 1881, but then they decided to be well ahead of the times, and on the advice of the late Dr. Alexander Kirk had the steamer *Aberdeen*, which they ordered, fitted with the first set of triple-expansion engines that had ever been applied to a large ocean-going steamer. This vessel was followed in 1884 by the *Australasian*, and then by the *Damascus*, and other vessels of the same high class were added as required. How great is the care taken of passengers is shown when it is stated that in all its long career not one of the company's vessels has ever lost a life except through natural causes. The vessels of this line travel by way of the Cape, where a call is made. The steamer *Miltiades*, added in 1903, accomplished on her maiden voyage the fastest passage ever made up to then from London and Plymouth to Melbourne, and a year or two after, when required at a few days' notice to take the running of the regular mail boat via the Suez Canal, landed the Australian mails more than 24 hours before time.

The old proprietary of Geo. Thompson and Co. was turned into a limited liability company in 1905, and both Messrs. Ismay, Imrie and Co., who represented the White

Star Line, and the Shaw, Savill, and Albion Company, Ltd., accepted the invitation to become interested in it. Hitherto its largest vessels were the *Marathon* and *Miltiades*, each of 6800 tons, but in 1907 the *Pericles* was launched by Messrs. Harland and Wolff, being named after an old clipper of the line which in her day was one of the finest and fastest ships ever built. The *Pericles* was a twin-screw steel steamer of over 11,000 tons register with two sets of quadruple-expansion engines, and her scantlings and fittings were in most cases considerably beyond the requirements of the Board of Trade and the Admiralty Transport Department. Her length was 500 feet, and her beam 62 feet. She was unfortunately lost in 1910 by striking an uncharted rock off the West Australian coast.

The first regular cargo line of steamers between England and Australia was established in 1880 by the late Mr. W. Lund, who previously owned a large number of sailing vessels. These steamers were started as cargo boats but carried a limited number of passengers, and as newer steamers were added they became very favourably known for the comfort of their accommodation. The first steamer owned by the Lund, or, as it is better known in the South African and Australian trades, the Blue Anchor Line, was the *Delcomyn*. In 1909, their largest steamer, the *Waratah*, a fine screw steamer of 9000 tons, was mysteriously lost with all on board between Durban and Cape Town. The Blue Anchor Line has recently been acquired by the P. & O. Company.

The Shaw, Savill, and Albion Company, Ltd., is an amalgamation, formed in 1883, of the two historic firms whose names it embodies. The united company ceased a couple of years ago to despatch sailing ships, but the main result of the combination has been the placing on the route of some of the finest passenger and cargo steamers afloat, and the inauguration of a fortnightly

service between London and New Zealand. Shaw, Savill and Co. in the early days made London their main port of departure, and just in the same way the Albion Company adhered to the Clyde. The joint concern covers the whole ground. The steamers of the line are built specially for the company, and are expressly designed for the Colonial trade, and are second to none in comfort, celerity, and security combined.

The outward voyage of the steamers is via Teneriffe, Cape Town, and Hobart; and the homeward trip is made via Cape Horn, calling at Monte Video or Rio de Janeiro and Teneriffe.

The company has played an important part in the development of the frozen meat traffic between England and New Zealand. The machines used are those patented as the "Haslam" and "Bell Coleman," known as the Patent Dry Air Refrigerators, though in the later steamers the CO_2 system is installed. The Shaw, Savill, and Albion Company, Ltd., were the pioneers in this trade. They fitted up the first sailing ship with refrigerating machinery, and successfully inaugurated an industry which has since grown to such vast dimensions.

The company is one of the largest carriers of frozen meat in the world, bringing over to this country in their steamers considerably over 2,800,000 carcases of mutton per annum.

All the company's present steamers are of steel, and most are twin screw, their tonnage ranging from 5564 in the *Karamea* to 10,000 in their newest boats, the *Pakeha* and *Rangatira*. Its service is maintained in connection with the White Star Line, which supplies four or five steamers of 12,000 tons each.

By few firms has such an extraordinarily rapid progress been shown as by that known as Elder, Dempster and Co., of which the late Sir Alfred Jones was the head. After his death the line was acquired by Lord Pirrie, who transferred

it to a new company bearing the name of Elder, Dempster and Co., Ltd. The firm originally consisted of Alexander Elder and John Dempster, who founded the British and African Steam Navigation Co., Ltd., in 1868, and in 1879 Mr. (afterwards Sir) Alfred L. Jones was admitted to partnership. Under his direction the firm became of considerable importance, but it was not until he and Mr. W. J. Davey became partners and sole managers that the firm progressed by leaps and bounds and rapidly became one of the largest and most influential commercial houses in the world. Its energies were tremendous and its successes no less so. The Beaver Line of steamers to Canada from Liverpool was at one time the property of this firm, who sold it to the Canadian Pacific Railway. The shipping companies controlled by Elder, Dempster and Co. included the British and African Steam Navigation Company (1900), Ltd., the African Steamship Company (incorporated under Royal Charter), Elder, Dempster Shipping, Ltd., Cie. Belge Maritime du Congo, Imperial Direct West India Mail Service, and the Compañia de Vapores Correos Interinsulares Canarios.

Only a few years have elapsed since the banana was almost a curiosity here, but thanks to the enterprise of Elder, Dempster and Co., who practically created the tropical fruit trade and built several steamers for the conveyance of tropical fruit to England, the banana has become most popular. The West India Islands, especially Jamaica, have derived immense benefit from this trade, the encouragement of this and other tropical products having brought it no small measure of prosperity. For this work the Imperial Direct West India Mail Service, Ltd., was established in 1901, maintaining at first a fortnightly and then a weekly service from Bristol to Jamaica. In connection with this service there are numerous inter-island services.

The Royal Mail Steam Packet Company in 1905

inaugurated their splendid "A" class of steamers, of which the *Aragon*, *Amazon*, *Avon*, *Araguaya*, and *Asturias* are examples. The largest of these is the *Asturias* of 12,500 tons.

In part directly and in part through its connections the company's enterprise extends to all parts of the world. It acquired in 1907 an interest in the Shire Line of steamers engaged in a regular service from London to Port Said, Suez, Colombo, Penang, Singapore, Hong-Kong, Shanghai, Nagasaki, Kobe, and Yokohama; and in 1908 it took over the old-established Forwood Line service from London to Gibraltar, Morocco, Las Palmas, Teneriffe, and Madeira.

The repairs effected to ships since they have been built of steel are no less wonderful than the building of the ships themselves. It is by no means uncommon for a ship to be cut in half, the pieces drawn asunder, and the intervening space built up. The repairing of the *Suevic* by fitting it with a new bow was not the first operation of the kind. The *Milwaukee* was similarly treated at Wallsend by Armstrong. The destroyer *Syren* lost her bows by stranding at Berehaven, but the after portion with the machinery was saved and given new bows by the Palmer Company, the two parts being towed to Haulbowline for the purpose. The Norddeutscher Lloyd steamer *Hudson* had her bows so badly damaged by fire that she had to be provided with new ones. Nor are the repairing feats effected by the steamers' engineers in mid-ocean, often in circumstances of extreme difficulty, less praiseworthy and remarkable, especially when it is a matter of patching a fractured propeller shaft while the vessel is rolling in the trough of a heavy sea and the work has to be performed in the semi-darkness of the shaft tube.

The steamer *Norfolk*, in 1906, after her engines broke down in the Indian Ocean, was taken into Fremantle under improvised sail. The sails were made of tarpaulins

The "Assiniboine" in Sault Ste. Marie Canal (Canadian Pacific Railway Co.).

p. 300

stitched together and the necessary spars were improvised out of derrick booms.

The steamer *Hansa* broke down in October 1908 in the South Pacific through the propeller jamming against the rudder stock. After a delay, the shaft broke when the steamer was 1281 miles out from Newcastle, New South Wales, for New Zealand. The shaft tank was flooded and the ship drifted in circles with sea anchors out, under such sail as the crew could set, while the engineers worked for almost twenty days—night and day—and sometimes more than waist-deep in water in the stern tube, till they managed to repair the shaft. Then the funnels of the steamer were used as masts and tarpaulins were rigged to them as sails. But such sails as they could set were insufficient and she drifted broadside on. The ship was picked up and finally brought into port, but by that time she was able to get her own engines to work and release the strain on the towing steamer.

Repair work of a totally different kind is associated with steamers built to be severed and joined up again. The Canadian Pacific Railway steamer *Assiniboia*, for instance, was constructed by the Fairfield Company at Govan in 1907 for service on the Great Lakes and was so made that she could be cut in half in order to pass through the canals to reach her destination, after which the pieces were reunited.

That a vessel should be built in order that she may be sunk and raised was the unique experience of the steamer *Transporter*, built by Messrs. Vickers, Sons and Maxim, Barrow-in-Furness, in 1908. Some time previously the Japanese Government placed with the firm an order for two submarine vessels, and a special steamer had to be constructed to carry them. This vessel is over 250 feet long, very broad and with large hatchways. When the submarines were ready for shipment the steamer was taken to Liverpool and sufficiently submerged in dock to

allow of them being floated into the hold. She was then pumped dry, and after being overhauled she left for Japan.

The most serious competitors British shipbuilders have are those of Germany. The industry there is of comparatively modern growth, and it is not more than a few years since all the large steamers required by German owners were built in Great Britain. All the early steamers of the Hamburg-Amerika Linie and also of the Norddeutscher Lloyd were constructed here, but in the early 'seventies, owing to the patriotism of a Secretary of State for the Navy in encouraging the construction of warships in German yards, shipbuilding was taken up in earnest and there are now shipyards in Germany capable of turning out steam-ships in every respect equal to the best that British establishments can produce. At first, German competition was not regarded very seriously by British builders, nor were German owners altogether enamoured of the products of their own yards owing to the lack of uniformity in the quality of the materials employed. The foundation of the Germanischer Lloyd during the 'sixties meant that a new influence was exercised upon German shipbuilding equivalent to that exercised by Lloyds upon the British mercantile marine. It was not, however, until 1882 that the Hamburg-Amerika Linie inaugurated the serious competition between German and British builders by entrusting the building of the mail steamer *Rugia* to the Vulcan Shipbuilding and Engineering works at Stettin, and the *Rhaetia* to the Reiherstieg Shipbuilding and Engineering Works at Hamburg. Previous to this the German yards had been constructing small steamers, the first of which there is any record being the *Weser*, built about 1816, at the Johann Lange yards. Iron shipbuilding was established at what is now the Stettin Vulcan yard in 1851 and the same year the "Neptun" yard was founded at Rostock. The first German iron steamer was built at

the Schichau Works at Elbing in 1855, and from 1859 to 1862 the machinery for wooden gunboats was supplied. Two iron steamers were launched by Klawitter at Dantzic in 1855, in which year also the Godefroy wooden shipbuilding yard, the present Reiherstieg yard, laid the keel of the first iron ocean-going steamer built on the North Sea coast. The Norddeutsche Werft was started in 1865 at the newly created naval harbour of Kiel, and in 1879 was united with the Maschinenbau-Gesellschaft, formerly Egells, whence arose the well-known Germania shipbuilding establishment.

Without entering upon debatable economic questions it may be asserted as a fact that German shipbuilding is a State-developed industry. Little was done until von Stosch, Minister of the Navy, in introducing a Bill for the establishment of a German Navy defined once for all the relations between the German Navy and the German industries. Not only did the State give assistance by the placing of orders, but further assistance was afforded in 1879 by the exemption from import duty of mercantile shipbuilding materials, a concession the importance of which was recognised when the Norddeutscher Lloyd placed an order with the Vulcan yard in 1886 for six imperial mail steamers for the East Asiatic and Australian lines. These were the first large iron passenger steamers built in Germany. Being Government mail steamers, German material was to be used in their construction as far as possible.

Before this, the Vulcan and the Reiherstieg yards had each shown what they could do by building an ocean steamer of about 3500 tons. Several English-built steamers were bought for the N.D.L. in 1881 and the following years, but in 1888–90 the company had three steamers of 6963 tons gross built by the Vulcan Company; these vessels had engines of 11,500 indicated horse-power and a speed of $18\frac{1}{2}$ miles an hour. In these steamers were adopted central saloons and a long central deck-house

with a promenade deck above, while on the main deck a dining-room, extending from one side of the ship to the other, was built. In these ships also German decorators and furnishers were given the opportunity to distinguish themselves and rival the British, and they did so. Steam-ship after steam-ship was produced, each one excelling its predecessor, until the N.D.L. decided upon the construction of the *Kaiser Wilhelm der Grosse* under the onerous condition that if she did not come up to the very strict requirements they imposed, the Vulcan Company should take her back. One condition was that the ship should be exhibited in a trial trip across the ocean to New York. The *Barbarossa* type, corresponding to the White Star intermediate vessels, appeared in the 'nineties, carrying a large number of passengers and having great cargo capacity. In 1894 the twin-screw vessels *Prinz Regent Luitpold* and *Prinz Heinrich* were added with special equipment for the tropics. Since then steamers have been added to the fleet with almost startling rapidity to cope with the company's many services, all the important German yards being favoured with orders. The largest steamer the company has is the *George Washington*, launched in November 1908 by the Vulcan Company, which is the greatest steamer yet constructed in Germany. She is 725½ feet in length with a displacement of 36,000 tons, while her gross registered tonnage is 26,000 tons. She is a first-class twin-screw steamer with five steel decks extending from end to end; she has also thirteen water-tight bulkheads, all of which reach to the upper deck and some even to the upper saloon deck. Contrary to the English practice, which is to reduce the number of masts as much as possible in these big liners, she has four masts, all steel poles, and carries 29 steel derricks. Her accommodation is for 520 first-class passengers in 263 staterooms, 377 second-class passengers in 137 staterooms, 614 third-class pas-

Photo. G. West & Son.

THE "KRONPRINZESSIN CECILIE" (NORDDEUTSCHER LLOYD).

Photo. G. West & Son.

THE "KAISER WILHELM II." (NORDDEUTSCHER LLOYD). p. 304

sengers in 160 staterooms, and 1430 fourth-class passengers in eight compartments, this vessel being the first in which four classes of passengers are carried. Besides the 2941 passengers she has a crew of 525. She has two four-cylinder, four-crank, quadruple-expansion engines of 20,000 horse-power, which give her a sea speed of 18½ knots.

With this steamer and four others only slightly less in size, the *Kaiser Wilhelm der Grosse*, the *Kronprinz Wilhelm*, the *Kaiser Wilhelm II.*, and the *Kronprinzessin Cecilie*, the company is able to carry out its ambition of maintaining a weekly express service between Bremen and New York.

The other great German shipping organisation, the Hamburg-Amerika Linie, started with a fleet of sailing ships, but inaugurated its steam service in 1856 with the *Borussia*, built by Caird of Greenock, who in the next few years executed orders for a number of vessels for the line. This steamer was one of the best of her day. The progress of this line, which claims with good reason to be the greatest shipping organisation in the world, has been extraordinary. Long ago it was adopted as its motto "My field the World," and well it has acted up to it. Its fleet had grown by 1897 to sixty-nine steam-ships with a total of 291,507 tons register, in addition to several smaller steamers for coastal and harbour work.

Its extension in the last few years has been phenomenal. Among its largest and fastest boats are the *Cleveland* and *Cincinnati*, *Koenig Wilhelm II.*, *Amerika*, *Kaiserin Auguste Victoria*, *Patricia*, *President Grant*, *President Lincoln*, and *Deutschland*, the last being one of the fastest afloat. Some of its larger vessels have been built at Belfast, notably the *Amerika*, and the *Spreewald* and others of her class at the Middleton yard, Hartlepool. In March 1909, the fleet comprised 164 ocean steamers of a total of 869,762 tons register, and 223 smaller steamers of 46,093

tons, or a total of 387 steamers and 915,855 tons. Both these companies, by their direct services and the numerous lines which they control, are in connection with every port of importance throughout the world.

With regard to engineering developments, it must be remembered that high-pressure and multiple-expansion engines were known before 1879.

The little *Enterprise* was engined by Wilson of London, in 1872, with a pressure of 150 lb.; the *Sexta*, engined by the Ouseburn Engine Works of Newcastle-on-Tyne in 1874, had boilers with a pressure of 120 lb. and triple-expansion engines working on three cranks; the *Propontis*, engined in the same year by Elder, of Glasgow, was also fitted with triple-expansion engines. Mr. Perkins' tri-compounds came out in the 'seventies, the *Isa* (yacht) in 1879, with a pressure of 120 lb.; and there were a few others. With the exception of the *Isa*, all the others may well be designated experiments that failed, and it was owing to the success of this little yacht that the possibility of the ordinary boiler for still higher pressures suggested itself.*

The *Propontis*, built in 1864, was re-engined and fitted with tri-compounds and new boilers in 1874. The boilers (of the water-tube type) were a failure, and were replaced by cylindrical boilers in 1876, at a reduced pressure of 90 lb. With these she worked till 1884, when her boilers were renewed. Dr. Kirk declared "that the want of a proper boiler had delayed the introduction of the triple expansion."

Plates of five tons in weight and upwards are in common use for boiler shells, yet in 1881 hardly a firm on the north-east coast would undertake to build a boiler for 150 lb. pressure.

The success of the triple engine resulted in many

* Paper on "Cargo Boat Machinery," by Mr. J. F. Walliker, Institute of Marine Engineers.

vessels being converted and fitted with new boilers, while others were re-engined.

Messrs. Palmer, in the *James Joicey*, fitted an interchangeable crank-shaft with the crank-pin on the centre engine, made with a coupling at each end to fit into a recess in the web. It was seen at quite an early stage of tri-compounds that the three-crank engine, with cranks at equal angles, from its easy turning moments, would be the most satisfactory, and its universal adoption in new engines was only the work of a very short time. The steamers *Aberdeen* and *Claremont*, both launched in 1881, were the first to have commercially successful triple-expansion engines

As to how high steam-pressures may go, it is recorded that the yacht *Salamander*, with triple-expansion engines, had the valve set at 600 lb.

The invention of the turbine has been the most remarkable event in the modern history of the steam-engine. The following passages, taken from the Hon. C. A. Parsons' paper on turbines, read at the Engineering Exhibition, 1906, give an account of its adoption for purposes of steam navigation :

" Turbines in general use may be classified under three principal types, though there are some that may be described as a mixture of the three types. The compound or multiple expansion type was the first to receive commercial application in 1884 ; the second was the single bucket wheel, driven by the expanding steam-jet, in 1888 ; and lastly a type which comprises some of the features of the other two, combined with a sinuous treatment of the steam in 1896. The compound type comprises the Parsons, Rateau, Zoelly, and other turbines, and has been chiefly adopted for the propulsion of ships. The distinctive features of these varieties of the compound type lie principally in design ; nearly all adopt a line of flow of the steam generally parallel and not radial to the shaft.

In the Parsons turbines there are no compartments: the blades and guides occupy nearly the whole space between the revolving drum and the fixed casing, and the characteristic action of the steam is equal impact and reaction between the fixed and moving blades. The chief object is to minimise the skin friction of the steam by reducing to a minimum the extent of moving surface in contact with the steam, and another, to reduce the percentage of leakage by the adoption of a shaft of large diameter and great rigidity, permitting small working clearances over the tops of the blades. The other varieties of turbines have all multicellular compartments in which the wheels or discs revolve."

The first vessel to be fitted with a turbine engine was the little *Turbinia*, in 1894, and successful though she was it was found necessary in the two following years to make a number of experiments which resulted in radical changes in the design and arrangement of the machinery. The first engine tried was of the radial flow type, giving about 1500 horse-power to a single screw. A speed of only 18 knots was obtained. Several different propellers were tried with this engine, and the result not being satisfactory the original turbine engine was removed, and the engines finally adopted consisted of three turbines in series—high pressure, intermediate pressure, and low pressure—each driving a separate shaft with three propellers on each shaft. A reversing turbine was coupled with the low-pressure turbine to the central shaft. The utility of the turbine for fast speed having been demonstrated by the *Turbinia*, the destroyers *Viper* and *Cobra* were built and given Parsons turbines and propellers, and the *Viper* showed herself the fastest in the world with a speed of 36·86 knots per hour. These two vessels came to grief, through no fault, however, of the turbines.

Captain Williamson, the well-known steamer manager on the Clyde, was the first to order a turbine-propelled

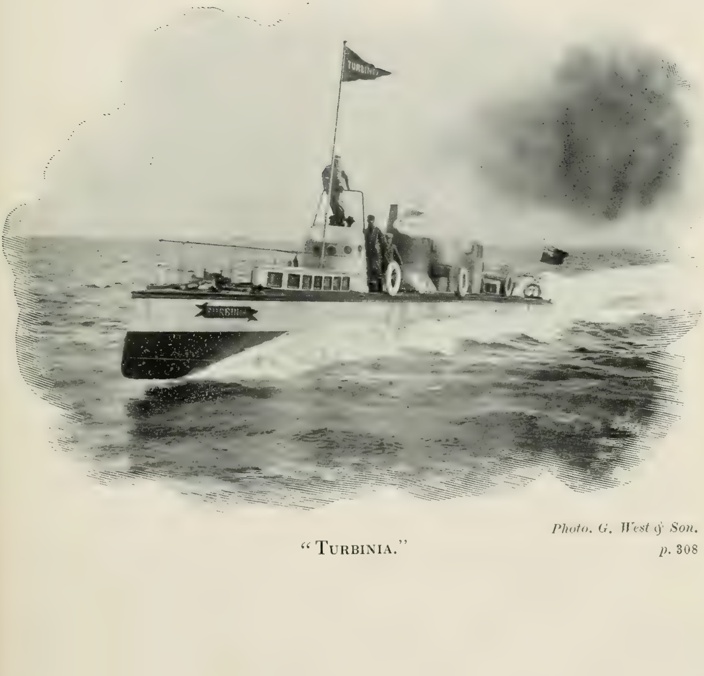


Photo. G. West & Son.

"TURBINIA."

p. 308

boat for commercial purposes, this being the steamer *King Edward*, built in 1901. She gave such excellent results that the *Queen Alexandra* was ordered. The South Eastern and Chatham Company was the first railway company to order a turbine steamer, *The Queen*, 310 feet long and of 1676 tons gross, with engines of 7500 horse-power. The first ocean liners fitted with turbines were the Allan liners *Victorian* and *Virginian*, built in 1904, each of about 10,754 gross tonnage and having turbine engines of about 12,000 horse-power. The Cunard Line built a turbine steamer in the following year, the *Carmania*, with turbines of 21,000 horse-power and of 19,524 tons gross. So satisfactory, apparently, was the experiment that the Cunard Line next ordered the *Lusitania* and *Mauretania* with turbine engines of 70,000 horse-power each.

After the two torpedo vessels already mentioned, the Admiralty ordered the *Velox* and *Eden*, which had additional engines for obtaining economical results at low speeds. Then came the third-class cruiser *Amethyst*, and comparative trials with sister vessels fitted with reciprocating engines showed the superior economy of the *Amethyst's* engines. Next the *Dreadnought* was fitted with turbine engines. Another conclusive proof of the superiority of the turbine was afforded by the steamer *Princesse Elisabeth* on the Ostend and Dover service, which in her first year averaged 24 knots as against the 22 knots of the *Princesse Clementine* and *Marie Henriette* on an average coal consumption per trip of 23·01 tons, compared with their 24·05 and 23·82 tons respectively. The turbine boat also does the trip in about 15 per cent. less time than the other two, or, "to reduce the turbine boat to the displacement and speed of the paddle-boats, and assuming that the indicated horse-power varies as the cube of the speed, the mean consumption of the *Princesse Elisabeth* would be about 17 tons as against 24 tons in the paddle-boats, thereby showing a saving of over 25 per

cent." Many other vessels have been fitted with turbine machinery, including the royal yacht.

The multiple propellers tried in some of the earlier vessels were found to be less satisfactory than single propellers on each shaft.

The first in which a combination of reciprocating and turbine engines was installed was the *Otaki* by Denny, for the New Zealand Shipping Company.

THE "OTAKI" (NEW ZEALAND SHIPPING CO.).

p. 310

CHAPTER XI

STEAM-POWER AND THE NAVY

THE steam vessels first built for the Navy were hardly worth calling warships and were of little or no value for fighting purposes. The first steam-propelled vessel in the Navy was the *Monkey*, of 210 tons, built at Rotherhithe in 1820 and fitted with engines of 80 nominal horse-power by Boulton and Watt. She had two cylinders of about $35\frac{1}{2}$ inches diameter and 3 feet 6 inches piston-stroke. The *Active*, of 80 nominal horse-power, was launched by the same firm two years later, and in 1823 Messrs. Maudslay began with the *Lightning* that connection with the Royal Navy which was maintained as long as the firm was in existence. Up to 1840 about seventy steam vessels were added to the Government fleet, the majority of which were given side-lever engines and flue boilers with a steam-pressure of about 4 lb. to the square inch above the air-pressure. All these vessels were chiefly used for towage and general purposes, including mail carriage when necessary, and not as warships. There was a gradual improvement in the size of the vessels, and in 1832 the *Rhadamanthus* was constructed by Maudslay, Sons, and Field with engines of 220 nominal horse-power and 400 indicated. Her machinery weighed 275 tons.

The steamer *Salamander* appeared in 1832, and thereafter several similarly propelled wooden-hulled steamers were added to the Navy. Between 1840 and 1850 tubular boilers were generally adopted, the boilers being lighter and more compact than those previously in use, enabling the working pressure of the steam to be increased to ten or fifteen pounds above that of the atmosphere. All these vessels had paddle-wheels. Warships similarly propelled were adopted by other nations also, but with the exception of skirmishes with the natives of uncivilised or semi-civilised countries, vessels of this type were not tested in serious warfare until the war in the Crimea. Even then many of the British and French warships were stately wooden three-deckers. Such vessels of the attacking fleets as were paddle-driven usually suffered badly about the wheels when they ventured within range of the Russian guns; while those, chiefly despatch vessels and gunboats, which had screws, were comparatively safe so far as their propellers were concerned, but were too weak to engage the Russian batteries. Floating armoured batteries were therefore decided upon, some of which had screw propellers, single or twin, but from the marine, apart from the military, point of view, they achieved no great success.

Long before this, however, the screw propeller had proved so reliable and the advantage of its position below the water-line was so obvious that the Admiralty could no longer maintain its prejudice, and the warsloop *Rattler* was built at Sheerness in 1843 and fitted with a screw propeller. Her displacement was 1078 tons. Her engines, of 437 indicated horse-power, had a spur gearing by which the revolutions of the screw were increased to four times those of the crank. The steamer *Alecto* had paddle-engines of the direct-acting type, and of about the same power as those of the *Rattler*. The two vessels were made fast stern to stern with only a short distance

between them to test the powers of their respective methods of propulsion, and although each did her best the screw boat towed the other at a speed of nearly 2½ knots. Of course a test of this sort could not demonstrate the superiority of one method over the other; all that it proved was that the *Alecto* was less powerful than the *Rattler*. A similar contest took place in the English Channel in June 1849, between the screw corvette *Niger* and the paddle-sloop *Basilisk*. The tug-of-war lasted an hour, and the *Niger* towed the *Basilisk* stern foremost 1·46 knots. These two vessels were very evenly matched in every respect, and the test in this case left no room for doubt as to which was the better method.

The first screw-propelled vessel in the British Navy was the *Dwarf*, built as the *Mermaid* by Messrs. Ditchburn and Mare at Blackwall in 1842, and as she attained at her trial the guaranteed speed of twelve miles an hour, the Admiralty fulfilled its promise and took her over and then renamed her. She was engined by Messrs. J. and G. Rennie. Her cylinders were vertical, of 40 inches diameter with 32 inches stroke, and the propeller was on their conoidal principle in which three blades are used, the surface of which, according to the specification, is "obtained by the descent of a tracer down the surface of a cone or conoid," this giving an increasing pitch. The vessel was 130 feet long and of 164 tons measurement. Three years later she was used for a series of experiments with a variety of screw propellers.

Of the many inventions brought under the notice of the Admiralty and of private shipowners, one which attained a considerable measure of success was the contrivance patented by Taylor and Davies in 1836, and known as a modified and improved form of Bishop's disc engine. It was tried in a pinnace, the *Geyser*, built in 1842 by Rennie.

In this form of engine the steam chamber is partly spherical, and the end-covers are cone-shaped, while the chamber contains a piston or circular disc-fitted with a central boss that fits into spherical seats made in the covers, and a projecting arm placed at right angles to the disc engages with a crank arm on the screw shaft. A fixed radial partition intersecting the disc divides the chamber into four cells, to which steam is admitted by a slide valve. In 1849 H.M.S. *Minx* was equipped with one of these engines having a disc of 27 inches diameter, in addition to the high-pressure engine, and coupled to the propeller shaft in such a manner that it was not necessary to disconnect the horizontal engines. With the disc engine the vessel attained a speed 11 per cent. higher than without. Improvements in other engines, however, rendered inevitable the relegation of the disc engine to the list of superseded contrivances.

In 1838 Mr. John Penn's oscillating engines with tubular boilers were fitted in some of the boats running above London Bridge, and attracted the attention of the Admiralty. The Admiralty yacht *Black Eagle* was turned over to him and he installed, instead of her former engines, oscillating engines of double their power, with tubular flue boilers, the change entailing no addition to the weight or engine space. The advantages of this installation were so great that many other vessels were similarly treated, among them being the royal yacht *Victoria and Albert*. His trunk engine, designed for the propulsion of warships carrying a screw, and capable of being placed below the water-line so far as to be out of reach of hostile shot, achieved an even greater success, and in 1847 Mr. Penn was instructed to place engines of this type in H.M.S. *Arrogant* and H.M.S. *Encounter*. These were so satisfactory that orders for engines were received for vessels ranging from a small gunboat, to be fitted with engines of 20 horse-power, to vessels like the *Sultan*, with

engines of 8629 horse-power, and *Neptune* (ex *Independencia*), with 8800 indicated horse-power. Up to the time of his death his firm fitted 735 vessels with engines having an aggregate actual power of more than 500,000 horses. Among them were the *Orlando*, *Howe*, *Bellerophon*, *Inconstant*, *Northampton*, *Ajax*, *Agamemnon*, *Hercules*, *Sultan*, *Warrior*, *Black Prince*, *Achilles*, *Minotaur*, and *Northumberland*.

The barque-rigged steam frigate *Penelope* attracted as much attention in the Admiralties of the world as did the advent of the first *Dreadnought* a few years ago. She was an ordinary 46-gun frigate, and might have attained neither more nor less publicity than fell to the lot of other ships of her class. Her conversion in 1843, however, into a steam frigate made her famous. She was described as "a war steamer of a magnitude unequalled in our own or any foreign service, with an armament that will enable her to bid defiance to any two line-of-battle ships, especially as her steam will give her the means of taking a commanding position." * She was one of the old French *Hebe* class of frigates, of which there were between thirty and forty lying in the various British ports in good condition, but considered useless, as larger frigates had been introduced by other powers. She was cut in half amidships and lengthened by 63 feet, the new middle space being devoted to her engines and boilers and to bunkers capable of holding 600 tons of coal. In addition to her crew of 300 officers and men, she could accommodate 1000 soldiers, with provisions and water for a voyage to the Cape of Good Hope. Her armament as a steamer consisted of two 10-inch pivot guns, each weighing 4 tons 4 cwt.; eight 68-pounders capable of firing both shot and shell, and fourteen 32-pounders. Her two steam-engines were believed to be of greater power than any yet made, having a combined horse-power of 625 horses. The

* *Illustrated London News*, July 1843.

cylinders had a diameter of 92 inches with a piston stroke of nearly 7 feet. The engines were direct-acting, and similar to those of the *Cyclops*, *Gorgon*, and other steam frigates in the Navy. A recess between the two foremost boilers contained the step for the main-mast, which therefore stood almost in the centre of the engine- and boiler-room. The funnel was placed abaft the main-mast, but the paddles were before it.

In 1845, Admiral Fishbourne adopted Scott Russell's wave-line principle and made certain recommendations as to the lines on which a ship of war should be built. These were: "the buttock-lines are continuous curves, to minimise pitching; with the same object a fine bow and full afterbody are provided. To promote steady steering there is a long run of perpendicular side, a long keel, a lean forefoot, and a fine heel, while to insure powerful action of the rudder the draught of water is greatest aft; the floor rises aft from the midship section."

But although shipbuilding of the modern type was initiated nearly three-quarters of a century ago, and iron vessels as warships had proved their utility more than once in the "affairs" of other nations, the British Admiralty remained faithful to wooden three-deckers long after a radical change in their allegiance would have been justified. It took a long time to convert the Admiralty. As early as 1842 an iron frigate was built by Laird at Birkenhead, called the *Guadeloupe*, for the Mexican Government. It was 187 feet long by 30 feet beam and 16 feet depth. An iron vessel, the *Nemesis*, was used in the Crimean War and was struck fourteen times by the enemy's shot, the holes in every instance being clean and free from splinters. The Admiralty was not convinced, however, and as late as 1861 ordered nearly a million pounds' worth of wood for warship construction. Other iron vessels carrying heavy guns, the *Nimrod*, *Nitocris*, *Assyrian*, *Phlegethon*, *Ariadne*, and *Medusa*,

were built for the East India Company at Laird's. The Admiralty had their first iron vessel, the *Dover*, built there, followed by the *Birkenhead* troopship, both paddle-steamers. The brigantine-rigged steam frigate *Birkenhead* was 210 feet in length between her perpendiculars, 60 feet 6 inches breadth outside the paddle-wheels, and 37 feet 6 inches inside the paddle-wheels, and had a depth of 23 feet. Her engines of 556 horse-power were by George Forrester and Co. A peculiar feature she had in common with several of her contemporaries was that she was clincker-built below water and carvel-built above. The unhappy ending of this ship is one of the most tragic events in the annals of the British Navy. She sailed from Queenstown, January 1852, for the Cape, having on board a portion of the 12th Lancers and of nine infantry regiments. She struck a pointed rock off Simon's Bay, South Africa, and of the 638 persons on board no fewer than 454 of the crew and soldiers perished. The remainder, many of whom were women and children, were saved by the boats.

The honour of being the first British steam iron warship belongs to the *Trident*, a paddle-steamer, launched from Ditchburn and Mare's shipbuilding yard at Blackwall in December 1845. Her length was 280 feet, the length of engine-room 45 feet, her beam 31 feet 6 inches, her breadth over paddles 52 feet 6 inches, her depth of hold 18 feet, and she was of 900 tons burden, includiug machinery, coals, water, guns, and stores. Her displacement at launching was 385 tons; the engines of 330 horse-power had oscillating cylinders, and her boilers were of a tubular pattern. She was designed by the builders. Her ribs were double, each rib being composed of two angle irons 4 inches by $3\frac{1}{2}$ inches by half an inch thick, riveted together, and in one entire length from the gunwale to the keel, there being 270 pairs of these double ribs. The iron skin was three-quarters of an inch thick at the keel, and half an inch at the gunwale. The skin contained

1400 plates of iron which were riveted to each other and to the ribs and the keel by 200,000 rivets. Each rivet was wrought red-hot and required the united labours of three workmen and two boys to fix it in its corresponding hole. The price of iron when the ship was commenced was £8 10*s.* per ton, and when it was launched £16. The *Trident* carried two long swivel guns of 10-inch bore, one forward and one aft, to fire in line with the keel, and had also four 32-pounder broadside guns.

The *Greenock*, built by Scott, Sinclair and Co. at Greenock in 1849, was a second-class steam frigate and was the first steam frigate ever launched on the Clyde for the British Navy. Her length was 213 feet and her tonnage 1413 tons Admiralty measurement, with engines of 565 horse-power by the same builders. The screw propeller was 14 feet in diameter, constructed on F. P. Smith's principle, and though it weighed seven tons, could be disengaged from the machinery and raised from the sea with ease. "The funnel also is to have some peculiar mode by which its hideous and crater-like physiognomy can be made at once to disappear, and leave the ship devoid at once of this unsightly feature, and of those cumbrous excrescences, paddle-boxes, giving her all the appearance and symmetry of a perfect sailing ship." * Her figure-head was a bust of the late Mr. John Scott, father of the head of the firm who built her. The keel, stem, and stern were of solid malleable iron, measuring 5 inches thick by 9 inches deep. The *Greenock* was the only one of four vessels ordered by the then Board of Admiralty, to be fitted as a frigate and propelled with full power. She was armed on the main deck, and her model was so designed as to enable her to fight her bow and stern guns in line with the keel, in which important qualification she stood almost alone in the Navy.

The value of private shipbuilding yards able to under-

* *Illustrated London News,* May 12, 1849.

take Admiralty work at short notice was abundantly proved during the Crimean War.

"In 1854, at the commencement of the Crimean War," said the *Times* in an article on the building of warships in private establishments, "when Admiral Napier found himself powerless in the Baltic for want of gunboats, it became imperative to have 120 of them, with 60 horse-power engines on board, ready for next spring, and at first the means for turning out so large an amount of work in so short a time puzzled the Admiralty. But Mr. Penn pointed out, and himself put into practice, an easy solution of the mechanical difficulty. By calling to his assistance the best workshops in the country, in duplicating parts, and by a full use of the admirable resources of his own establishments at Greenwich and Deptford, he was able to fit up with the requisite engine-power ninety-seven gunboats. This performance is a memorable illustration of what the private workshops of this free country can accomplish when war with its unexpected requirements comes upon us. . . . Altogether during the Crimean War 121 vessels were fitted with engines for our Government by Mr. Penn."

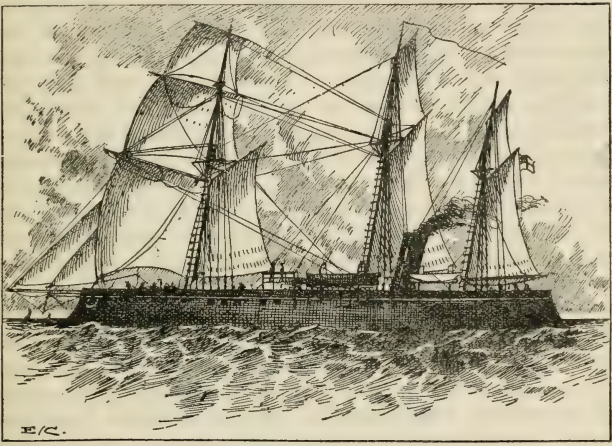
Two paddle-wheel gunboats, *Nix* and *Salamander*, were launched in 1851 by Messrs. Robinson and Russell for the Prussian Government, which exchanged them during the Crimean War for a frigate called the *Thetis*, and they were renamed *Recruit* and *Weser*. They were double-ended and could steam in either direction without turning. The paddle-frigate *Dantzig*, built by the same firm for the same foreign Government, had the peculiarity of being able to carry guns on her sponsons. The last wooden battleship built for the Navy was the *Victoria*, 121 guns, launched in 1859, commissioned in 1864, and discarded in 1867. She was engined by Maudslay with horizontal return connecting-rod engines indicating 4400 horse-power and giving her a speed of 12 knots. The *Bann* and

Brune were built by Scott Russell as improvements on the *Salamander*, and were on the longitudinal system with wave-lines, and they had internal bulkheads separating the engine and boiler rooms from the bunkers.

The success of the floating batteries at the Crimea was held by the French to justify the construction of a sea-going ironclad, and the *Gloire* resulted. Experiments in America had shown the possibility of the plan, but the French naval architect, Dupuy de Lome, considered that it would be sufficient to plate existing vessels. The *Gloire* was a big wooden ship cut down and iron-plated.

This stirred the Admiralty to activity and the *Warrior* was ordered. The launch of this vessel on the Thames was regarded as an event of national importance, and in spite of the cold day at the end of December 1860 on which she took the water, the attendance was exceedingly large, even the tops of the tall chimneys of the neighbourhood having been let out for the day to enthusiastic sightseers. She was frozen down to the ways so firmly that it was with the utmost difficulty that she could be got into the water at all. Tugs, hydraulic presses, the hammering by hundreds of men on the ways, and the firing of cannon from her deck to start her by concussion were all tried separately and then together, and at last the ship glided slowly into the water. The beauty of her lines was remarkable as she floated in her light trim, and afterwards, when she was properly equipped and in sea-going trim, she was one of the most beautiful ships the country ever possessed. She was iron built throughout, frame and plating being alike of the metal. She was 420 feet over all, 58 feet in breadth, and 41 feet 6 inches in depth from spar deck to keel. She was of 6177 tons builders' measurement. Her engines, which were of 1250 nominal horse-power, weighed about 950 tons, but her bunkers only held 950 tons, or enough coal for six days' steaming. She was divided into twenty-seven water-tight

compartments at the bows and stern, and as the whole of her sides were so armoured as to afford protection to the vital parts of the ship, it was stated that even if the fore and stern parts of the ship were shot away, the centre would remain as a floating battery.



THE "WATERWITCH."

The *Waterwitch* is chiefly remarkable for the trial given in her to Mr. Ruthven's system of hydraulic propulsion. A small boat was fitted with the machinery and tried on the Thames. A vessel provided with the Ruthven apparatus was built to the order of the Prussian Government in 1853, and for many years worked satisfactorily on the Oder. The chief engineer of Portsmouth Dockyard, when testifying to the Government as to the capabilities of the Ruthven method, said it afforded extraordinary facilities for manœuvring under steam, and he saw no reason why a speed should not be attained with it equal to that of the paddle or screw. A vessel called the

Seraing was built by the Belgian shipbuilding firm of Cockerill and fitted with a Ruthven propeller, and when tried against a paddle-wheel vessel of the same form, tonnage, and horse-power was found to have about 10 per cent. greater speed than the other. The testimony of the chief engineer of the Portsmouth Dockyard resulted in the *Waterwitch* experiment. The hull of this vessel was constructed by the Thames Iron Works and Shipbuilding Company, and the design of the engines and the construction of the enormous turbine wheel, of which the propeller consists, were entrusted by the Admiralty to Messrs. Dudgeon. The *Waterwitch* was built of iron and was of 778 tons measurement, 162 feet in length by 32 feet in breadth, and 13 feet 9 inches in depth. She was flat-bottomed, broad in proportion to her length, and double-ended and had a rudder at each end. Her armour consisted of a belt of plating 4½ inches in thickness at the water-line and centrally on her broadside, with armour-plated bulkheads across her upper deck, the object of the latter arrangement being to enable her to fight her guns over her deck in line with her keel, through gunports in the thwartship bulkheads as well as through broadside ports. For the machinery, and in the bottom of the vessel near the centre, was a long and shallow iron box with its length in the direction of the vessel. The lower side of this box had an immense number of small rectangular orifices, admitting water from outside and under the ship's bottom, the passage of the water being controlled by valves which were only opened when the engines were at work. The turbine wheel drew the water in through the bottom of the vessel and ejected it through copper propulsion pipes and nozzles, through an aperture on each side of the ship, a little below the water-line.

The propelling power of the hydraulic wheel is obtained from the force and volume of the column of water ejected by the wheel from the discharge pipes, on a principle that

a gun recoils on being discharged, but with this difference, that the recoil from the water-wheel is continuous. If the column of water were discharged towards the stern the vessel moved forward, and if towards the stem it moved in the other direction; if discharged in both directions the vessel remained stationary, and if discharged forward on one side and towards the stern on the other, the vessel turned either on her centre as on a pivot, or if the pressure were greater in one direction than in the other, in a circle the size of which depended on the pressure of the discharge from either set of nozzles. No reversing of the engines or of the hydraulic wheel was required under any circumstances, the direction and force of the discharge being regulated by a series of valves. The hydraulic wheel was fixed immediately over the sluice valves and water-box, and revolved in a cast-iron circular case 19 feet in diameter. The wheel was itself 14 feet 6 inches in diameter and weighed eight tons, and was fitted with eleven vertical or radial arms and blades. The engines were of 160 nominal horse-power, and steam was supplied by two ordinary tubular boilers. At her trial the *Waterwitch* covered the measured mile in Long Reach in 6 minutes 20 seconds. At other trials later in the day she averaged 9 knots.

The shape of the vessel and the fact that she could be steered in either direction with equal facility were of undoubted advantage from the point of view of manœuvring, but the trials can hardly be called successful so much as experimental, as it was ascertaiued that she would probably have done better had her nozzles been differently placed and provision made for altering the size of the nozzles according to the speed at which the vessel was required to travel. The machinery itself, however, worked beautifully.

The Government ordered a number of comparative tests to be made in which the efficacy of the *Waterwitch*

method could be judged against that of the double-screw system installed in the gunboats *Viper* and *Vixen*, all three vessels being of the same size. The two gunboats were not the best of their kind as they had double sternposts with a cavernous recess between them and flat overhanging sterns.

Mr. M. W. Ruthven, son of the inventor of the system, it being under his father's patent that the *Waterwitch* machine was built, in addressing the Institute of Marine Engineers a few years ago, said:

"My efforts to make a ship safe, from an engineer's point of view, lie in the method of propulsion. My plans are to apply all the engine-power of the ship to pumps for propulsion, and which can be used for pumping out leakage and propelling at the same time. In the largest pump I have made, 800 indicated horse-power discharged 350 tons of water a minute, and propelled the vessel faster than her sister ships with twin screws. The hydraulic propeller is of greatest value for the highest speeds, and has the greatest power of control. As the hydraulic is capable of subdivision to a great degree, the greatest amount of safety is possible. After an experience of sixty years of hydraulic propulsion, I am still of opinion that it is the means by which greater safety can be obtained at sea, and by which the highest speeds can be obtained with safety and economy." *

This, however, was said before such phenominal speeds were obtained with turbines and combined turbine and reciprocating engines.

A number of lifeboats fitted with jet-propelling machinery have been built by, among others, Messrs. Thornycroft, and have given every satisfaction. Whatever be the advantages of the system, and they are many, the drawbacks are very great, and the hydraulic method has been generally condemned because of the friction

* *Institute of Marine Engineers' Transactions*, vol. ix.

engendered by the pumping of such large quantities of water, and the probability of the inlet orifices becoming choked by sand, mud, or floating matter.

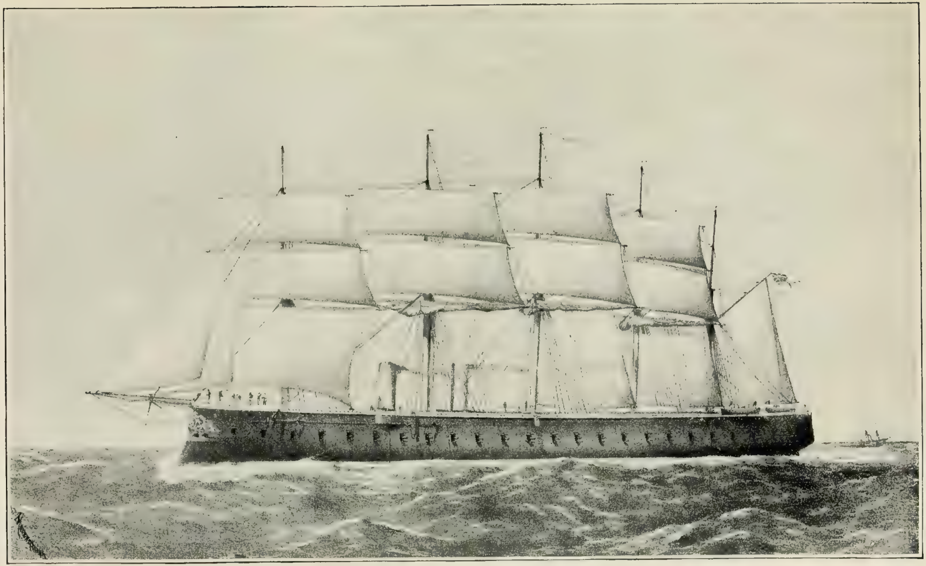
Notwithstanding its evident advantages, the screw propeller, whether single or double, had many enemies. It was asserted to be the cause of premature decay in both wood and iron vessels, and stringent orders were even given to ship captains to use canvas except in extreme cases when steam was absolutely necessary. "Our screw navy is, therefore," said a paper of that period, "more of a sailing than a steam navy." The twin-screw arranged by Messrs. Dudgeon was claimed to have developed the principle in such a way as to leave no doubt of its superiority over the single propeller. Twin-screws were no new thing at this time. Captain Smith, known as "Target Smith" because of his movable target in use on the *Excellent*, had experimented with some with a considerable measure of success, but it was Messrs. Dudgeon who solved the problem of twin-screw propellers for ocean-going steamers. They demonstrated that as good results could be got from two small propellers as from one large one.

The first application of twin-screws on the modern principle was made by Messrs. J. and W. Dudgeon in the *Flora* in November 1862.

Twin-screws were tried by the Admiralty some years earlier in the construction of the iron-cased floating batteries, but were driven in those vessels by one motion from the engines. The adoption of the twin-screw in their case enabled the Admiralty to build vessels that required only a moderately light draught of water, and carried, for their tonnage, an enormous weight of armament and armour, besides the weight of their engines; but the vessels had no increased powers of turning nor could they manœuvre rapidly under steam in any circumscribed space. The double independent screws overcame these drawbacks.

A small vessel in the Clyde worked two screws also, with two rudders, the idea, as acknowledged by the adaptor, having been derived from the model exhibited in the Exhibition of 1851 by Mr. John Sturdee, master shipwright's assistant at Portsmouth Dockyard.

An unusual degree of interest attached to the trial of the steam-ship *Flora* by reason of the fact that each of her twin-screws was to be operated by its own engine. In the light of future events it is worthy of note that up to this time it was thought that the twin-screw would be useful for smaller vessels and gunboats carrying six guns or less; whereas the *Flora*, as representative of ships capable of carrying large armaments of guns, with considerable engine-power, and a light draught of water, and with a power of manœuvring such as could not be possessed by a single-screw vessel, marked a step forward in the march of improvement which was destined to have far-reaching results, both in the Navy and the Mercantile Marine. So important was the trial deemed that the Admiralty sent special representatives to report thereon. The *Flora* was an iron vessel, 150 feet long, 22½ feet beam, and 13 feet depth, and of 365 tons. She had two independent engines and screws, the latter being placed one under each quarter, and therefore in front of the rudder, in contrast to the prevailing system of placing a single screw right astern and behind the rudder. The cylinders of the two engines were 26 inches in diameter, with a stroke of 21 inches; and the propellers were each of 7 feet diameter with a pitch of 14½ feet. She had two tubular boilers working at 30 lb. pressure, and one high-pressure boiler working at 50 lb. pressure, the latter boiler being intended to be used for producing a steam blast in the chimney and to dry the steam from the two common boilers. The engines were of 120 horse-power collectively. She was rigged as a fore-and-aft schooner. The principal test to which the vessel was subjected tried



H.M.S. "MINOTAUR."

p. 326

her capabilities of being manœuvred. With the helm hard over and the engines going full speed ahead, the first circle was made in 3 minutes 14 seconds, the next in one second less time, and the third circle in 3 minutes 16 seconds, the diameter of the circle being about three lengths of the ship, but slightly diminished each time. The ship was then tested with one screw working ahead and the other astern. One circle was made in 3 minutes 39 seconds, and another in 3 minutes 49 seconds; "in making these circles the action of the ship's hull was extraordinary, the central part being stationary, and both ends moving round equally. The circle was made on a pivot from the ship's midship section. The vessel was then put in a straight course, stopped, and from a state of rest the engines were started, one ahead and the other astern, the circle being completed in 3 minutes 55 seconds and the diameter being as before within the ship's length." * The *Flora* proved herself faster than any other steamer of her size and horse-power, and became, thanks to her speed, one of the most successful blockade-runners during the American Civil War.

The experiments in the *Flora*, and afterwards in the *Hebe* and *Kate*, which were of about the same dimensions and power, were considered so satisfactory that a trial on a larger and more important scale was made in the summer of 1863 with the *Aurora*. This was an iron vessel, 165 feet in length, with a beam of 23 feet, and a depth of 13 feet 6 inches. Her engines, of 120 collective nominal horse-power, drove two three-bladed screws, each independently of the other; the screws were 7 feet in diameter and had a pitch of 14 feet 6 inches. The cylinders were of 26 inches in diameter with a stroke of 21 inches. On her trials she steered equally well with either propellers or rudder, and in the matter of speed passed everything she came across, including the *Sea*

* *Illustrated London News*, November 29, 1862.

Swallow, one of the fastest paddle-boats on the Thames. The distance from Tilbury to the Nore, twenty nautical miles, was done in 1 hour 17 minutes, "an almost unparalleled rate of speed, considering the vessel's horse-power of engine and hull displacement." *

The *Experiment* was the first twin-screw boat built for the Navy. The engines were direct-acting, horizontal, high-pressure, and drove two three-bladed propellers, having a diameter of 3 feet 6 inches. She was built by Dudgeon in February 1863.

Some interesting experiments were also carried out in February 1863 with a steamer called the *Edith*, built by Dudgeon with a view to testing further, for the benefit of the Admiralty, whose representatives were present, the advantages of the twin-screw for naval manœuvring purposes. This vessel was not constructed for the Navy, however, but for commercial service across the Atlantic. She was rather larger than the *Experiment*, being 175 feet in length, 25 feet in breadth, and drawing 9 feet aft and 6 feet 6 inches forward. The twin-screws, each driven by its own engine, were three-bladed and had a diameter of 8 feet 6 inches, and a pitch of 16 feet. On her trial run down the river with the Admiralty officials on board, a speed was attained of nearly 12 knots against the tide, and nearly 15 knots with the tide, the engines averaging 100 revolutions a minute under 28 lb. steam-pressure. The vessel turned a complete circle in 3 minutes 29 seconds with her own centre as a pivot, and then the action of both screws was suddenly reversed. Their action upon the vessel was instantaneous, the revolving motion of the ship being changed to the opposite direction with the greatest ease. The manœuvre was repeated several times, and the vessel thus represented a revolving battery mounted with heavy ordnance, too heavy for training upon any given object by ordinary appliances. The hull

* *Times*, August 1863.

Photo. G. West & Son.

THE "KOENIG WILHELM," GERMAN NAVY.

Photo. G. West & Son.

THE "BADEN," GERMAN NAVY.

p. 328

became the carriage for such heavy guns, and trained them upon any given point by revolving under the action of the screws alone.

The American Navy up to the time of the Civil War was not taken into very serious consideration by the other nations, but in that momentous struggle the Federals awoke to the need of thoroughly effective vessels and built them quickly. They were the last to take to iron ships of war but they more than made up for the delay. In scarcely a year after the launch of Ericsson's *Monitor*, the first ship of its class possessed by the Federal Government, there were built, or building, close upon twenty of these vessels. Various modifications were introduced but the principle was the same. This was the turret on the deck, where the armament of the vessel was placed, it being sought to construct an effective battery for defensive operations rather than to build a sea-going ship.

The contest between the Confederate iron protected *Merrimac* and the Federal wooden warships, which ended disastrously for the latter, and the battle between the *Monitor* and the *Merrimac* proved that the old wooden three-deckers had become obsolete and that they would be perfectly useless against a steam ram like the *Merrimac* and harmless against an ironclad ram like the *Monitor*.

For a time rams and turrets were regarded as all-important. The extreme in this combination was reached in the French ironclad ram *Taureau*. She was one of the most peculiar warships ever constructed. Seen end on she looked like a tremendous buoy, surmounted by a turret, a funnel, and two masts. A side view showed that an immense bow extended forward as a long ram, and that the turret was situated near the bows. The prow was of bronze and weighed eleven tons, and projected some forty feet under the water. Her deck view represented her as almost pear-shaped, with cylindrical sides, and she had her greatest beam at about the water-line.

She was iron-clad for about three feet above the water-line amidships and aft, but the turret and bows had 5 inch armour. Altogether she was about 197 feet long by 48 feet beam, and carried one heavy gun in the turret.

A combination of three-decker and ironclad ram was the French warship *Magenta,* constructed in 1862. She had an enormous ram like the *Taureau* and carried eighty guns, and was barquentine rigged.

In England, Captain Coles began in 1859 to urge the construction of vessels of the cupola or turret type, and after the lesson of the famous contests in America between the two ironclads, the British Admiralty decided to try Captain Coles' boats experimentally. He advocated the cutting down of the three-deckers into one-deck ships, carrying on this one deck one or more turrets or cupolas in which the guns should be placed. These turrets were capable of being turned so that the guns in them could be fired in any direction, and he proposed that a portion of the bulwarks should be hinged in order that they could be let down when it was required to fire the guns, and thus form a sort of additional protection to that portion of the ship's side above the water-line, while when raised they would add to the seaworthiness of the vessels by keeping the water off their decks. Vessels built according to Captain Coles' plans, it was contended, would be floating defences "which would be at once thoroughly manageable, impervious to shot, movable with ease, and seaworthy. Nor would they be so monstrous and unsightly to a nautical eye as the inventions of our American cousins. They would be fitted with masts and yards, having the one peculiarity of being made of one uniform size, so that ships of all classes abroad could be furnished at depots, in case of accident, or ships meeting each other could exchange with or supply their comrades," to quote from one of the descriptions published at the time. Another advantage was that the conversion of

Photo. G. West & Son.

H.M.S. "DEVASTATION."

Photo. G. West & Son.

H.M.S. "THUNDERER."

p. 330

heavy frigates and line-of-battle ships into iron-plated vessels, fitted with the Coles shield, could be effected at a comparatively moderate cost. Experiments with the cupola were tried on the *Trusty* and *Hazard* with success. The standardisation of masts and rigging was another point on which Captain Coles laid stress. The cupola system had so much to recommend it that Sir William Armstrong wrote to the *Times* endorsing it as solving the problem of working the heaviest guns. Could shipbuilding have stood still at that period the system would have been an unqualified success, but the rivalry between armour-makers and gunmakers was so intense that no sooner did an armour-plate maker produce a plate impenetrable to existing guns and projectiles than the gunmakers set to work to produce a gun and projectile which should smash the armour plate.

The steam corvette *Pallas*, launched at Woolwich in 1865, differed materially from any other vessel hitherto constructed. She was originally intended to be built of iron, but as the necessary machinery was not then in existence at Woolwich, she was constructed of wood and iron-plated, and had a belt of armour to protect the most important parts. She was rigged as a ship so that she might keep at sea for a considerable time, the sails enabling her to economise her fuel. In order to increase her seaworthiness she was made high above the water, her fixed bulwarks being eighteen feet above the water-level. She was also designed to be able to fight end on. The engines were of 600 horse-power, and, to counteract the enormous strains the screw propeller was expected to impose, a new system of stern construction was adopted whereby the sternposts and deadwood were connected with the sides by internal iron bulkheads, decks, and flats, and external brass castings. The *Pallas* was 2372 tons burden, and was intended to be a faster vessel than any wooden frigate in the Navy. The fastest wooden frigate afloat and

complete then was the *Mersey*, which once got up to $13\frac{1}{4}$ knots an hour. The *Pallas* was provided with Mr. Reid's new bow, known as the U bow from its shape. This bow gave considerable buoyancy where it was needed to support the ram, but its shape created a wave forward and thus militated against the vessel's speed.

H.M.S. *Minotaur*, launched in 1865, was almost the last of the great sailing warships carrying a ram and having powerful auxiliary machinery. She had five square-rigged masts, and all five topsails were on the divided principle.

The German ironclad *Prinz Hendrick*, built by Laird Brothers of Birkenhead, and launched in October 1866, was barque-rigged, and was fitted with Captain Coles' tripod masts. She was also fitted with revolving turrets, hinged bulwarks, and a sliding funnel.

The *Hercules*, begun in June 1866, and launched in February 1869, was one of the best specimens of the entirely iron-built, iron-armoured frigates the Navy possessed at that time. Her ram bow did not protrude so far as in former vessels and only weighed about five tons. The armour plating on the sides of the ship weighed 1145 tons. The total weight of metal worked into the ship was 4252 tons. The bulwarks were of wood, but below them the first two strakes were of plates 6 inches thick; next was a strake of 8-inch armour covering the lower portion of the main deck or central box battery; then two strakes of 6-inch armour, then a belt of 9-inch armour along the water-line, then a strake of 6-inch plates resting above the double skin of the hull itself. The 9-inch plates were backed by 10 inches of teak, inside of which was an iron skin $1\frac{1}{2}$ in. thick, supported by vertical frames 10 inches deep and 2 feet apart, while further stiffening structures were also included. The engines worked up to over 7000 indicated horse-power. The vessel also afforded an illustration of the tendency to

H.M.S. "Dreadnought."

p. 332

reduce the number of guns and increase their weight. To add to her steering capacities she had a balanced rudder which was itself jointed and hinged upon the line of pivot.

The carrying of such quantities of armour was against the maintenance of high speed at sea, and accordingly the unarmoured iron frigate *Inconstant* was launched later in the same year. She carried sixteen guns and was faster than any other warship afloat.

The Prussian ironclad *Koenig Wilhelm*, built by the Thames Iron Works and Shipbuilding Company, from designs by Mr. E. J. Reid, in 1869, was commenced for the Turkish Government, and was built on the longitudinal system, having a series of wrought-iron girders or frames extending from end to end of the ship. There was an inner skin on the inner sides of the frames and ribs, as though one ship was inside another. She was then the heaviest vessel ever docked in the Thames, as she weighed 8500 tons. Her armour was 8 inches thick amidships and tapered slightly towards the ends.

The year 1869 was remarkable for the introduction into the British Navy of large ironclads without masts or sails and relying upon steam alone for their propulsion, and these vessels also demonstrated the most perfect form then understood of the turret ship as applied to a sea-going warship of large capacity. The *Devastation*, built at Portsmouth, and the *Thunderer* at Pembroke, were the first of this class, and were claimed to be more formidable than any other warships in existence both for offence and defence. They were each of 285 feet in length and 4406 tons, as compared with the first ironclad *Warrior*, 380 feet and 6019 tons, and the *Minotaur*, of 400 feet length and 6021 tons. The *Warrior's* armour was 4½ inches of hammered plate that would break under the impact of heavy shot; that of the *Minotaur* was 5½ inches of rolled armour, in each vessel there being a strong backing of teak and iron plating built into the

frame. The two turret ships had 12 inches of rolled armour plating on a teak backing built into an immensely strong framing 18 inches thick, and the whole was backed up with an inner skin of iron plating $1\frac{1}{2}$ inches thick. The thickest armour then in use in the French Navy was $8\frac{1}{4}$ inches and was carried only by rams of the *Bélier* class. These vessels also included an improvement in the bracket-frame system of construction, first introduced in the *Bellerophon* by Mr. Reid. The "breastwork monitor" of the *Devastation* type was regarded as an improvement on the American types of monitors. The turrets were mounted on Captain Coles' system and each turret carried two 30-ton guns. The ships were driven by independent twin-screws and had a speed of $12\frac{1}{2}$ knots.

In 1870 the ill-fated *Captain* was lost. She was designed by Captain Coles and built by Messrs. Laird as a sea-going turret vessel. The principal armament was four 25-ton Armstrong guns carried in two turrets, one fore and one aft; these turrets were 27 feet diameter outside and $22\frac{1}{2}$ feet inside, half the thickness of the wall consisting of iron plating. This ship behaved admirably on her trials and also on an experimental cruise, and was sent to sea with the fleet in September of that year. From some reason never explained satisfactorily she capsized without warning, and went down in a few seconds during a gale in the Bay of Biscay before daylight on the morning of September 7. Only nineteen of the 500 persons on board were saved, among the drowned being Captain Coles himself.

This disaster evoked such an amount of criticism as to the vessel's stability and seaworthiness that no more of the type were constructed, the turret ships subsequently built being modifications of the principle.

Armour-plated batteries found their chief representatives in the batteries of the time of the Crimean War, of which the *Glatton* and *Terror* may be regarded as

Photo. G. West & Son.

H.M.S. "Lightning."

Photo. G. West & Son.

H.M.S. "Tartar," Torpedo Boat.

p. 334

types, and the double-turret principle was developed in such vessels as the *Cerberus.* The *Terror* was built by Palmer's for the destruction of the Cronstadt forts. She had three masts carrying square sails on the fore-mast, and excessively sloping sides and bluff ends, and would form a remarkable contrast to the graceful lines of the modern battleship. The *Terror* was built, armour-plated, and launched in about three months, thanks to Sir Charles Palmer's invention of rolling instead of forging the armour plates.

The battle of Tsushima afforded naval architects some valuable lessons, and the *Dreadnought* and the *Lord Nelson* may be regarded as the first results. The Japanese-built *Satsuma* is virtually on the same lines, there being little to choose between the *Satsuma* and the *Lord Nelson.*

The *Dreadnought's* turbine machinery drives four shafts, and immediately aft of the inner shafts are twin rudders to give the ship greater steering facilities. The Admiralty adopted turbines, according to an official statement, because "of the saving in weight and reduction in number of working parts, and reduced liability to breakdown; its smooth working, ease of manipulation, saving of coal consumption at high powers, and hence boiler-room space and saving of engine-room complement; and also because of the increased protection which is provided for with this system, due to the engines being lower in the ship: advantages which more than counterbalance the disadvantages. There was no difficulty in arriving at a decision to adopt turbine propulsion from the point of view of seagoing speed only. The point that chiefly occupied the committee was the question of providing sufficient stopping and turning power for purposes of easy and quick manœuvring. Trials were carried out between the sister vessels *Eden* and *Waveney*, and the *Amethyst* and *Sapphire*, one of each class fitted with reciprocating and

the other with turbine engines. . . . The necessary stopping and astern power will be provided by astern turbines on each of the four shafts.

"These astern turbines will be arranged in series, one high- and one low-pressure astern turbine on each side of the ship, and in this way the steam will be more economically used when going astern, and a proportionally greater astern power obtained than in the *Eden* and *Amethyst*."

Messrs. John I. Thorneycroft and Co.'s first torpedo-boat for the British Navy was the *Lightning*, of 18 knots, but the firm's *Tartar*, launched in 1907, broke all records by travelling at 35·67 knots.

The latest destroyers have a speed of 33 knots, though the coastal destroyers have a speed of only 26 knots. Another remarkable feature in the Navy of late years has been the number of vessels to be fitted with oil-burning apparatus instead of coal.

The destroyer *Mohawk*, built by J. Samuel White at Cowes, is 270 feet in length, 25 feet beam, and 765 tons displacement, and contains water-tube boilers and turbines of 14,000 horse-power, and attained a speed of forty miles an hour. She carries no coal, oil fuel being used, of which her bunkers can take seventy-three tons. The *Tartar's* record was broken by the destroyer *Swift*, 345 feet in length with a displacement of 1800 tons, and having quadruple turbine engines giving her a speed of 36 knots.

The cruiser *Invincible*, launched by Armstrongs at Elswick in April 1907, is a first-class armoured cruiser 530 feet in length and of 17,250 tons displacement, and has turbine engines of an equivalent horse-power of 40,000 and a speed of 25 knots.

The construction of warships has resolved itself into a struggle to attain an ever-increasing speed combined with offensive power and great range of action, and warships

Photo. G. West & Son.

H.M.S. "LORD NELSON."

Photo. G. West & Son.

H.M.S. "INVINCIBLE," ARMOURED CRUISER. *p.* 336

of varying types have been produced with startling rapidity, so that one powerful vessel after another has been evolved, each superseding its predecessor in some degree, until there are "Dreadnoughts" and "Super-Dreadnoughts" carrying guns and armour and possessing a speed undreamt of a few years ago. Among smaller vessels, torpedo-boats, destroyers, scouts, cruisers of various classes, commerce destroyers, cruiser-battleships, and submarines now take their places in the nation's fleet. There is no telling in what direction the next development will be. The battle of the boilers has played an important part in the development of the warship, and it is safe to say that had this struggle not taken place to produce a boiler which should give a great pressure of steam quickly, the speed of the warship as now known would not have been attainable. Twin screws are succeeded by triple screws, and these are to be followed by quadruple screws.

The second-class protected cruiser *Bristol*, launched at Messrs. John Brown and Co.'s Clydebank establishment in February last, is of special interest as she embodies the introduction of yet another method of propulsion. When it became known that an experiment was to be made there was some speculation as to whether the gas system was to be tried, as the experiments in the gunboat *Rattler* are understood to have been successful, and it is well known that more than one engineering firm has been giving attention to the subject. The *Rattler* experiments did not prove that the requisite power could be developed by the method, and the *Bristol* experiment is an installation of the "Brown-Curtis" turbine, this vessel being the first of recent years for the British Navy in which Parsons turbines have not been placed. She is of 4850 tons displacement and is to have a speed of 25 knots. Four sister ships, also building, are fitted with Parsons turbines. The *Bristol* will have twelve Yarrow water-tube boilers, and the

furnaces will use either coal or oil. Two other British warships, one an improved *Bristol*, are to be fitted with Curtis turbines, besides vessels for other Powers, and another experiment which will be watched with considerable interest is the combination of Parsons and Curtis turbines proposed to be placed in the 32-knot destroyers under construction for the Argentine Government by Cammell, Laird and Co.

Foreign Governments, the French especially, have made many experiments in warship building and designing, for the attempts to develop fixed types have failed in this country as elsewhere, as the type has been generally superseded almost before the specimen vessel has been completed. This was particularly the case with the turrets when first introduced. The barbette system has descended from it, and in turn has been subjected to numerous changes. The amount of sail carried by modern gunboats and cruisers, if any, is reduced to the smallest quantity, the masts being little else than signalling poles; while in the big battleships and cruisers the masts, which were at one time of the "military" pattern and were used as hoists for ammunition, being made hollow and of large diameter for the purpose, have in their turn given way to skeleton masts and tripods, and combinations of the two, of a strictly utilitarian character. The bringing down of a mast, fitted for wireless telegraphy, at the first round in some firing practice recently, showed that naval architects have not yet reached the last word in the development, or diminution, of the masts.

Some exceedingly powerful battleships have been built in this country for foreign nations, among the latest being the *Minas Geraes*, by Armstrongs on the Tyne, for Brazil, which represents all that is most modern in the construction of a warship, this vessel and her sister being two of the most powerful battleships ever designed. They show, too, what private yards can accomplish.

THE "MINAS GERAES," BRAZILIAN NAVY.

p. 338

Many of the vessels which defeated the Russians at the battle of Tsushima were built in this country. Both Germany and Japan, which were among Britain's best customers for warships, now depend, entirely in the case of Germany and almost entirely in that of Japan, upon their own shipbuilding yards. The Germans have been building warships of the "Dreadnought" class and making such improvements as they thought suited to their needs, and of late years have been producing a number of vessels equal in power and speed to the British ships, and, if some people are right, of even greater fighting capacity in every way. The rise of Germany to the position of a first-rate Naval Power has been rapid, and the sacrifices the country has made to obtain its magnificent Navy have been great.

The American Navy has developed in its own way. The naval architects of the United States have been unfettered by the traditions of the navies of other countries and their products have been remarkable for the number of vessels designed to meet special circumstances. This was particularly the case during the Civil War, when all sorts of steamers, from excursion boats to tugs, were pressed into service, and many gave an exceedingly good account of themselves. A remarkable vessel which was expected to revolutionise naval warfare was the *Destroyer*, in which a special make of dynamite gun was fixed, but it was hopelessly outranged by other guns. The opposition to steam in the Navy was as bitter in America as in this country when the innovation was first proposed. James Kirke Paulding, a member of Van Buren's Cabinet in 1837, disliked steamers so much that he wrote that he would "never consent to see our grand old ships supplanted by these new and ugly sea-monsters"; and elsewhere he wrote "I am steamed to death."

In 1858 the American naval architect, John Willis Griffiths, built to the order of the American Government the gunboat *Pawnee*, which was fitted with twin screws

and a drop bilge to increase the stability at the least expenditure of engine-power. The *Pawnee* carried a frigate's battery, but it is stated to have drawn only ten feet of water. He also, in 1866, designed and constructed triple screws for great speed.

The United States decided upon a very powerful Navy a few years ago, and sent a splendid fleet on a tour round the world as an object-lesson. As it is contended that the life of a battleship as a fighting unit of the first class is only fifteen years, an extensive modernising process has been going on. The sister ships *Kentucky* and *Kearsarge* were constructed with superimposed turrets, two fore and two aft, the lower turrets having two 13-inch guns and the upper turrets two 8-inch guns each, but this method of placing the turrets has not commended itself to naval architects of other countries, and has not been repeated in the American Navy.

The warships *Wilmington*, *Kearsarge*, *Missouri*, *Arkansas*, *West Virginia*, *Charleston*, *Virginia*, *North Carolina*, and *Delaware* are among those built by the Newport News Shipbuilding and Dry Dock Company, and several have been constructed by Messrs. Cramp at Philadelphia and by the Union Iron Works at San Francisco.

The battleship of the future, in the opinion of one eminent shipbuilder at least, will be very different from existing types. Messrs. Vickers, Sons, and Maxim, who are no mean authorities on warship construction, were stated recently to have been engaged in elaborating plans for a mastless vessel, propelled by a system of gas machinery, without funnels or other deck obstructions, of a greater speed than any warship afloat, and able to fire ten 12-inch guns on either broadside and six of them either right ahead or astern, without counting a number of smaller guns. Such a vessel would be propelled by four screws.

Photo. G. West & Son.

THE "KEARSARGE," U.S. NAVY.

Photo. G. West & Son.

THE "SAN FRANCISCO," U.S. NAVY.

CHAPTER XII

MISCELLANEOUS APPLICATION OF STEAM-POWER

Tugs—Cargo-boats—Floating Docks—Ferries—Icebreakers—Yachts—Eccentricities of Design—Conclusion

NOT the least important of the types of steamers which throng the ports of the world—or which used to do so, for their number is decreasing—is the tugboat. Up to a few years ago it played a most important part in the work of a port; every sailing ship entering port usually engaged the services of a tug; many ports, like that of London, could not be entered at all by a large sailing ship without the services of "a fair wind ahead," as sailors often call the tug, and in the waters outside the Port of London the tugboats found one of the best "pitches" in their business. To be towed safely into port might mean a saving of many days in avoiding the waiting for a wind. The tug was equally useful to a ship leaving port, as she might not only tow her into the open sea, but might even take her right out of sight of land altogether, in helping her along until a favourable slant of wind was met. At ports like Liverpool sailing-ship masters often, when wind and tide were favourable, brought their ships into port under full sail without a tug, though probably three or four of them kept her company in the hope that their services would be required, as they generally were when the time came to enter dock.

Nowadays sailing ships are few in number and are becoming fewer, and steamers seldom require aid. They enter and leave port under their own steam and even at times dispense with a tug when passing through the dock entrance, their own steam or a steam capstan ashore being found sufficient.

But a certain amount of towing has still to be done, and the tug is then able to prove herself indispensable. She has often to tow a ship from one coast port to another, while for rescue work on the coast their services mean all the difference between success and failure. A lifeboat is towed to a wreck or vessel in danger. The tug, which has perhaps been several hours fighting her way forward against a howling gale and a terrific sea which threatens to overwhelm her, then stands by, and a paragraph in the papers to that effect is about all the recognition she gets, yet the perils undergone by the men on the tug are no less real than those of the lifeboatmen. Year in and year out the tugs pursue their calling, and it must indeed be bad weather that will induce a tugboat captain to seek the shelter of a harbour if his bunkers are fairly full and he sees a chance of doing business.

The feats performed by some tugs are extraordinary. They will undertake a voyage of a few thousand miles as serenely as one of as many yards. Cleopatra's needle, in its strange cylinder ship, was towed to this country, after being lost adrift in the Bay of Biscay, by a well-known London tug. Among the most remarkable recent feats are the towing of immense unwieldy floating docks from this country to South American west-coast ports; it is not too much to say that a tug-owner will cheerfully undertake to tow anything that will float from any one seaport to any other.

The cargo steamer until ten or fifteen years ago possessed no special features. It was simply a big box carrying propelling machinery and as much cargo as possible on the

smallest attainable registered tonnage. Such vessels were usually loaded and discharged by the necessary machinery on the quay side, while if the transfer of cargo had to be to or from barges alongside, the operation was likely to be tediously performed by means of a derrick or two, or a gaff with tackle that might or might not be worked by a steam-winch. The increasing size of vessels and the use of steel for steamer building rendered imperative the adoption of faster methods, and the demands for special steamers adapted for particular trades brought about the development in cargo steamers of special types. These types have to a very large extent taken the trade away from the steamer of the "tramp" class, which wandered from port to port taking cargoes of anything or everything from anywhere to anywhere. They were usually slow and uncomfortable boats and the complaints made as to the condition of some of them were fully justified. The demand for better cargo accommodation was met by the supply of vessels of various types which are a tremendous advance upon the old "tramp," and their advent compelled the builders of ordinary cargo carriers to produce a better and larger steamer in every way, and fitted with modern appliances for the rapid and satisfactory handling of cargo.

The cargo "tramps," built about 1902, were on an average about 350 feet long, 2800 tons gross and 4000 tons dead weight. In build they were of the poop, bridge, and forecastle deck type with main deck below the upper deck, and fitted with double bottoms. The appliances for working cargo are extraordinarily complete and effective. To each hatch there are usually two winches and two derricks, having 5 tons lift each, with, as a rule, a heavy derrick capable of lifting from 20 to 30 tons; the last is portable, so that it can be used at either of the two main hatches. Cathead davits have been dispensed with as, with stockless anchors, they are not required owing to the anchors stowing up the hawse pipes. Officers, &c., are berthed in

deckhouses built on the bridge deck, leaving the bridge 'tween deck clear for cargo. Electric light and steam-heating are fitted to all rooms, advantages not enjoyed by older boats.

About the year 1904 the shelter-deck type reached its present stage of perfection, the advantage of this type being increased cargo capacity on a small net tonnage. The accommodation of officers and engineers is fitted in midship deckhouses and side houses. Much more attention is now paid to the ventilation of the holds and 'tween decks, more especially in coal-carriers, where efficient ventilation is of the highest importance. The adoption, within very recent years, of wide-spaced pillars in holds and 'tween decks has greatly improved the facilities for stowage of large cargo.

The four desiderata of a modern cargo-boat are that she should have a low registered tonnage in comparison with her capacity, ample water-ballast tanks, large hatchways, and holds as free from obstruction as possible. Three or four methods are practised by builders for attaining these objects, and every builder has made modifications of them as time has shown the necessity of the changes to meet varying trade conditions.

The principal types of cargo vessels are the turret, trunk, cantilever, and side tank.

The earlier modern ocean-going steamers were usually flush-decked. This left the machinery openings bare in the deck, so a bridge was added for their protection, and the flush deck was further encroached upon by the addition of a forecastle and poop. In some cases the quarter deck was raised, which was an awkward arrangement on account of the change it necessitated in the structure and framing, and in others the bridge and poop were joined. What is sometimes called the "three island" type, a very appropriate name in rough weather when the steamer takes a sea on board, came into great favour; it consists of a forecastle, bridge, and poop, and many vessels of considerable

size have been built in that style. The cattle trade was responsible for some important changes in design, the "wells" where the cattle are carried being given iron and steel shelters, which thus form the shelter decks, a type of light deck introduced into the superstructure of most ocean-going steamers.

The secret of the turret steamer is strength without unnecessary weight. Every ton of steel that can be kept out of a ship without reducing her strength adds a ton to her carrying capacity. This object is partly achieved in the turret steamer by the large amount of flanging adopted in the construction of these vessels. This is shown in the whole of the sheer strake and stringer plates, in the deck and frames of the cellular bottom work, and with great success in the joggled plating of the hull. Since 1895, when the Doxfords introduced a new method of rolling ships' plates with joggled edges, they have built all their vessels under this system, making "packing" unnecessary. The turret gives longitudinal strength in the hull and leaves the hold clear. The strength is so great that in a steamer in which, by the substitution of deep for ordinary frames, all internal supports, beams, and girders are dispensed with, a clear hold is obtained. The firm claims that 58 cubic feet per ton dead weight under hatches is secured against 52 to 54 cubic feet per ton in the ordinary type. Thus the turret carries more on a given displacement, and having a lower registered tonnage, can earn more freight and save expenses. There are several designs of turret steamers adapted to different trades. Their suitability for bulk cargo, such as coal, or for large and heavy packages, is evident, while other types are equally suitable as passenger steamers, not a few lines having adopted them. Another advantage is that deck cargoes of wood can be carried with perfect safety on the turrets. Some of the cargo-boats designed for the ore and coal trade have their machinery right aft, and their holds are absolutely

clear of obstruction of any kind whatever. Many of these are mastless but are fitted with twin derricks, a 10,000-ton boat carrying as many as seven pairs. The first of the mastless type was the *Teucer*. Convention fixed the depth of hold at about 15 feet, but now a depth of 26 feet and more is becoming fairly common. All cargo vessels are built on the box-girder system, which ensures great strength and capacity, and permits of enormous hatchways, and marine engineers have solved the problem of providing greater speed without additional expense.

Messrs. Doxford, in their latest attempt to solve the problem of the easily-shifting cargo in bulk, proposed that vessels intended for this trade should have inner upright walls fitted some distance from the hull, and so arranged that when the vessel is heeled over within the usual range of inclinations of a vessel at sea, the weight of the cargo and the buoyancy create a restoring couple in all conditions of loading. The spaces between the cargo-hold and the outer shell may be left empty or used for water-ballast as required. In some instances the bottom is reduced in depth as much as the loading regulations will allow.

Among the more notable features of recent years in cargo-boats specially adapted for the coal, iron ore, and other dead-weight trades is the patent cantilever framed type of steamer built by Sir Raylton Dixon and Co., Ltd., Cleveland Dockyard, Middlesbrough, on the Harroway and Dixon patents. This type of boat has the advantage of having totally unobstructed holds with very large hatchways and an additional 75 per cent. water-ballast, which is placed in the tanks inside the cantilever construction at the top of the holds under the deck. In these steamers the space on either side and under the decks is used for water-ballast, which is carried in triangular tanks at either side of the vessel, immediately beneath the main deck. The tanks extend from the coamings to the sides of the ship, the greatest side of the triangle being towards the

cargo and supported by the cantilever framing; the tank framing and plating increase the strength of the hull materially. The sloping topsides thus formed prevent bulk cargo shifting. An advantage to the owner is that the tanks are exempt from tonnage measurement. When these tanks are filled with water and also the lower and peak tanks the vessel is seaworthy even if the cargo-space is empty.

This additional water-ballast has the special merit of immersing the ship deeper when in ballast only, consequently giving more power to the propeller and rendering the ship more manageable when light, as well as supplying unique security in case of damage, for when one of these boats is loaded and the topside tanks are empty, they correspond to the air tanks of a lifeboat and thus prevent the ship from sinking.

These vessels in some cases have been fitted with shelter decks right fore and aft for the carriage of cattle and horses, and indeed would be suitable for passenger service, for which the very easy rolling movement would be a great recommendation.

This type of vessel has been on the market for about four years and already some 200,000 tons have been built. One of the largest steamers built on this plan is the *Echunga*, 405 feet long, 56 feet beam, and 28 feet 8 inches moulded depth. She was built in 1908 for the Adelaide Steamship Company. Her net register is 2245 tons, her dead-weight capacity 8400 tons, and her measurement 11,000 tons. Her topside tanks contain 1350 tons, and her total water-ballast is 3200 tons.

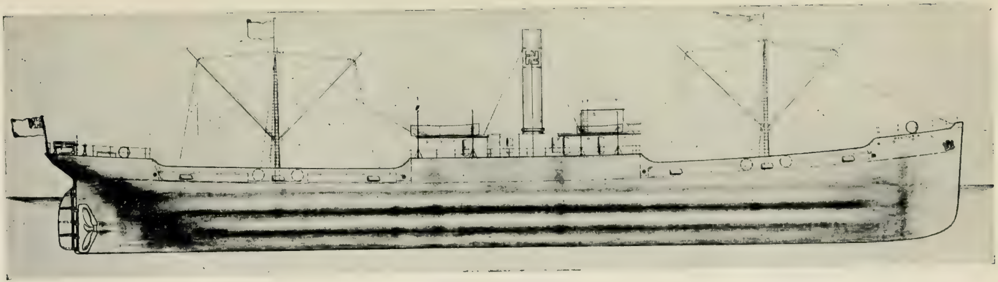
In the steamers built by Messrs. William Gray and Co., Ltd., of West Hartlepool, water-ballast is carried not only in the double bottoms but in side tanks, the inner skin of the double bottoms being carried a considerable distance up the sides. A hull within a hull is thus formed, the intervening space being used as water-ballast tanks. Not

the least advantage is the great additional strength the ship is given. The trunk system of shipbuilding adopted by Messrs. Ropner and Sons, Ltd., of Stockton-on-Tees, differs from the turret by having a double wall on each side, and has not the rounded turret base. The steamer *Thor*, built for a Norwegian owner, has only one hold, no less than 250 feet in length, the engines being placed aft.

Messrs. R. Craggs and Sons, Ltd., of Middlesbrough, have made a speciality of building tankers, and were the designers and contractors for the first ocean steamer to load oil in bulk. Their stringerless system of construction is, they claim, the last word in transverse framing, and has numerous advantages for single-deck vessels.

During the last three years three distinct innovations in steam-ship construction have been made. All three are of a revolutionary character, and two are likely to have no small influence upon the construction of both passenger and cargo steamers, while the third is of great importance for the rapid loading and discharging of coal and ore cargoes. The first of these is the Isherwood system of longitudinal ship construction, in which the transverse frame as ordinarily understood is dispensed with, but deep transverse web frames are placed at intervals of 15 to 18 feet apart and extending right round the ship, forming both frame and beam together. These frames are intersected by longitudinal frames consisting of sections of convenient form, preferably bulb angles, spaced about 20 to 30 inches apart, just as transverse frames are under the ordinary system. The fore and aft frames are fitted beneath the deck also, and are spaced from 30 to 50 inches apart. In the double bottom the fore and aft girders are formed of plates and angles.

The first general cargo vessel on this plan was the *Craster Hall*, launched in February 1908 by Messrs. William Hamilton and Co., Ltd., Port Glasgow. Her



The "Monitoria."

The "Iroquois" and the "Navahoe."

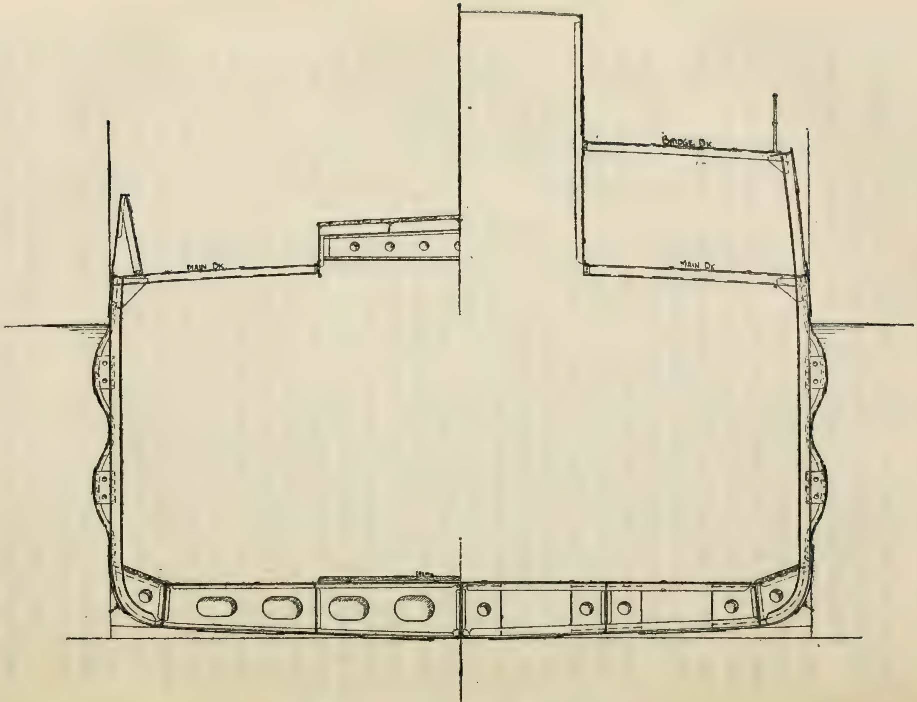
p. 348

length is 392 feet 6 inches; breadth, 50 feet; depth, 29 feet to the upper deck; dead weight, 7300 tons.

Two oil-tankers, the *Paul Paix* and *Gascony*, have been built by Messrs. Craggs and Sons on this system. One of them grounded off Calais with a cargo of oil or benzine on board, and on being dry-docked for examination was found to have no damage to her plates whatever. All the steamers built on the Isherwood plan have a marked absence of vibration even when running light.

The corrugated steam-ship *Monitoria*, launched in the summer of 1909 by Messrs. Osbourne Graham and Co., Sunderland, to the order of the Ericsson Shipping Company of Newcastle-on-Tyne, is another departure from accepted ideas. She is an ordinary "tramp" steamer so far as dimensions and engine-power go; her only difference, and it is an important one, is that she has two corrugations running along each side between bilge and load waterline, and extending from the turn of the bow to the turn of the quarter. These corrugations do not project very greatly, but according to the inventor, they so affect the stream and wave action around and under the vessel that a source of wasted energy is prevented, and more power becomes available for propulsion. The *Monitoria's* dimensions are: length, 288 feet 6 inches over all; breadth, 39 feet 10½ inches; the breadth over the corrugations is nearly 42 feet. The space for bulk cargoes is greater than on her sister ships by the cubic contents of the corrugations, but the tonnages remain unaltered. As a sea-going ship it was found that the corrugations made her much steadier, acting as though they were bilge keels, and that the coal consumption was less, notwithstanding that she made faster time than her sister vessels under precisely similar conditions.

The third innovation is the application of the belt-conveyor principle to a collier. The steamer *Pallion*, in which the machinery is installed, is equipped throughout



The "Monitoria": Transverse Section

with twin belt conveyors which, travelling fore and aft the vessel in a space under the cargo, carry the cargo towards the stern, whence it is carried on other belts at the front of the poop for delivery. The latter belts are carried on swivel booms which can be raised or lowered or moved sideways, so that the cargo is delivered direct by the belts into railway trucks on the quay or into barges, and the operation can be conducted at the rate of 250 tons an hour on each side of the vessel simultaneously. Under this system no shoots are used, and there is no handling of the coal. The *Pallion* requires only about six hours to discharge a full cargo with six men, as against over a hundred men and eleven hours in the ordinary way. Her water-ballast tanks can be emptied or filled as fast as the cargo is placed in her or taken out. She was built by the Doxford firm at Sunderland for a Newcastle Shipping Company.

The carrying of petroleum in bulk has spread enormously of late years in both steamers and sailing vessels specially designed for the purpose. In all such vessels the method of the subdivision of the holds into tanks is of the greatest importance, together with that of ventilation, and every builder and owner of such vessels has his own theories as to the best means to be adopted. A later type of tanker has the engines astern. A further innovation in this class of steamer is to fit them for burning oil fuel, the two big tankers *Oberon* and *Trinculo* having had the necessary installation placed in them last year at Smith's Dock, North Shields, sometimes called "the home of tank-steamer repairing work."

An economical method of transporting oil in bulk across the Atlantic is adopted in the case of the steamer *Iroquois*, which herself carries about 10,000 tons of oil in bulk, and also tows with her the sailing barge *Navahoe*, carrying an equal quantity, one set of engines thus doing duty for both cargoes. The *Navahoe* is the largest sailing

ship in the world, is schooner-rigged on all her six masts, and is able to make her way to port in case she becomes separated from her consort.

The floating dock is one of the most interesting of the many developments in connection with the naval and mercantile marine of the second half of the nineteenth century. Like all innovations, floating docks were received with derision.

Now they have proved their worth, but circumstances are easily conceivable in which all the marvels they have already accomplished will be far eclipsed by what they may be called upon to do. In the case of a naval battle, for instance, it may be a matter of impossibility for a crippled warship to enter a dry dock, or even to get to one; but a floating dock can be sent to meet the injured warrior and possibly save it from going to the bottom altogether.

The floating dock is a sort of raft, and the first man who ever hauled a boat from the water upon another boat or raft to repair, it started the idea of the floating dock. The first real floating dock, as the term is now understood, was probably that which was improvised in the Baltic Sea, so tradition says, by the skipper of a vessel which had sustained some damage in those waters. He bought an old hulk, removed the stern, and in its place constructed a flap gate. His vessel was then floated into the hulk, the flap gate was closed and the water pumped out. Floating docks of this type were almost the only kind known up to the beginning of the nineteenth century, and are in use to-day at some ports for small yachts, fishing-boats, and vessels of similar dimensions.

With the growing size of vessels, greater docking facilities became necessary, and, as the commerce of the world increased and ports were developed, demands arose for docking accommodation which could not always be met, owing in some cases to financial difficulties, and in others

to the engineering difficulties connected with the localities. As a solution of the problem, the floating dock, as it is known to-day, was invented. In spite of the opposition with which it was greeted, the new contrivance held its own, and its merits became generally recognised.

The difficulties and the cost of constructing dry docks are very great, and the time taken in the work may run into years; one dock, indeed, is stated to have taken fifteen years to complete.

As an instance of rapidity of floating-dock construction, the Vulcan Company of Stettin required a dock 510 feet long and of 11,000 tons lifting power at short notice. The complete dock with all machinery and fittings was launched within seven and a half months, and within eight months and thirteen days of the inception of the project, the dock, after being towed across the North Sea and moored in place at its site, was sunk ready to receive its first ship. The Havana dock was delivered at Havana within eleven months after the signing of the contract for its construction; the actual time expended on it, dating from the day the first plate was laid until the complete dock was launched, was six months and a day. Both these docks are of over 10,000 tons lifting power. How long would it have taken to excavate and build graving docks capable of receiving vessels of the size that these docks can accommodate?

No dry dock can take a vessel larger than itself, and in reckoning the dimensions of a dock for receiving purposes it must be remembered that its cill is a fixture, that the width of the entrance at the cill must not be made greater than the strength of the structure will permit, and that though a dock may in other respects be able to receive a vessel it cannot do so if that vessel through any mishap should draw as much water as that at depth of cill, or if in heeling over, its bilges should be wider than the width of the dock entrance. None of these drawbacks apply to the floating dock. These immense modern structures of

steel and iron can receive vessels longer than themselves, and in the case of the off-shore docks, can receive vessels wider than themselves.

Should a vessel be heavily down by the head or stern, a floating dock can be tilted to lift it, and should the vessel be heeling over, the dock itself can be inclined so that it shall receive it without difficulty. Yet another advantage is that the floating dock can be used in any kind of ordinary weather. Lying at its moorings it is head on to wind and sea. The amount of surface it opposes to the direct action of wind and sea is comparatively slight. The very massiveness of its structure reduces longitudinal and lateral motion to a minimum, especially when submerged. Even with a fairly heavy sea running, a damaged and leaking vessel can be brought upon the dock where its weight, added to that of the dock itself, makes the combined structure additionally stiff, so that the necessary repairs can be undertaken in safety as soon as the vessel is lifted, and with as much ease as if the dock and its burden were in still water. Floating docks also can be used at any state of the tide, but he would be a rash man who attempted to warp a vessel into an ordinary dry dock with the tide running past the entrance with any degree of strength.

The earliest type of the modern floating dock is that known as the box dock. It consists of a pontoon divided into cells or compartments, and having on either side a large wall also divided into compartments arranged in tiers, the ends of the structure between the walls being open. The earliest of these docks were made of wood, and compared with those of later date were of small dimensions. One of the most noteworthy wooden docks was that at Rangoon, launched in February 1866, and having a length of 300 feet, with a breadth of 90 feet, and an inside breadth of 70 feet, and able to take vessels drawing from 15 to 16 feet of water. There is also at

OLD FLOATING DOCK AT ROTHERHITHE,
circa 1800.

p. 354

Altona a wooden floating dock built in 1868 and still in active use; it is 138 feet in length, and can lift vessels up to 420 tons register. The early floating docks were usually in transverse section like the capital letter U, and followed fairly closely the form of the round-bottomed ships of the time. As the girder principle, however, became introduced in shipbuilding it was recognised that floating docks must be constructed approximating to that shape, and modern floating docks are now built rectangular in transverse section, though in constructional details this form is a modification of the U shape.

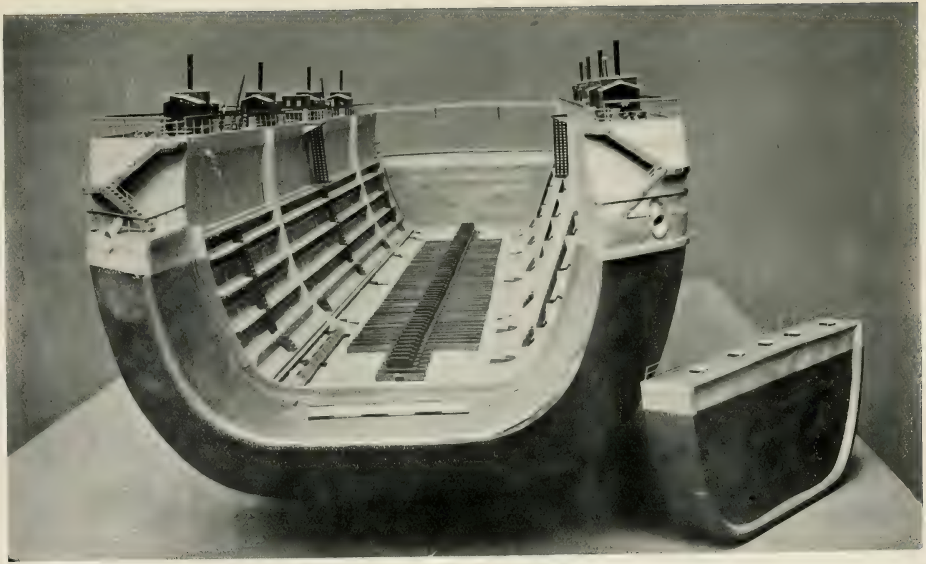
Floating docks themselves are in occasional need of repair, and when it was found that they could be constructed of a greater size than any then existing dry dock, it being customary to dry dock them for repair, the necessity arose of devising a means whereby the repairs could be made without taking the floating dock out of the water. Sometimes a dock can be tilted endways or sideways as occasion requires, for a portion of its under-water surface to be exposed, but there is obviously a limit to this operation and to the effectiveness with which work under these conditions can be carried out. This difficulty was met by constructing docks on the sectional principle, whereby any two sections of a floating dock constructed in three sections can lift the other one; while with off-shore docks, which are usually built in two sections, either can lift the other. An attempt to careen the old U-shaped Bermuda dock nearly capsized her altogether.

One of the earliest—if indeed not the earliest—of self-docking double-sided docks is that associated with the name of Mr. Rennie, and now generally known as the Rennie type, or, in an attempt made at uniform classification of self-docking docks by Messrs. Clark and Standfield, who probably have had greater experience of floating-dock designing than any other firm in the world, the "sectional pontoon" dock. This is an extremely simple form of dock,

consisting of a series of similar pontoons connected together into a whole by the walls or side girders, which run along each side on top of the pontoon, to which they are attached by bolts. In self-docking, any particular pontoon can be unbolted from underneath the walls, allowed to sink slightly, and then be drawn out sideways, turned half round, and lifted on the rest of the dock. The type is also very suitable for erection abroad, for the pontoons can be built and launched separately, and, being but light structures, require no expensive launching slips, whilst the side walls can be erected on top of the pontoons after they are afloat.*

The first Bermuda Dock, launched at North Woolwich by Messrs. Campbell, Johnstone and Co., in September 1868, was the largest built up to that time, and was ordered by the Admiralty for the use of British ships in the West Indian Squadron. It was 381 feet in length, 123 feet 9 inches in extreme breadth, and had a total depth of 74 feet 5 inches. Caissons enclosed a dock space of 333 feet by 83 feet 9 inches in width, capable of receiving a vessel of 3000 tons. The section of the dock is of U form throughout, though for convenience of towing, a tapered bow of wood was added, and remained until it rotted off at Bermuda. The dock was designed by Mr. Campbell. The sides consisted of a cellular space 20 feet in width, and midway between the inner and outer skin was a water-tight bulkhead, running the whole length of the structure. Each side was subdivided by longitudinal bulkheads into three compartments, named from the bottom, the "air," "balance" and "load" chambers, and was further subdivided into twenty-four water-tight cells. The dock was fitted with four steam engines and pumps on each side. Hitherto all floating docks had been built in sections, shipped to their destinations and erected there. The Bermuda dock, however, was towed there, experiment-

* "Modern Floating Docks," by Lyonel Edwin Clark, M.I.N.A.



Model of the Bermuda Dock.

p. 356

ally, and so successfully was the work accomplished that the towing of floating docks across the ocean has become the rule, and some wonderful feats of towing have been performed. This dock, becoming unequal to the requirements of modern shipping, gave place to the present dock built at Wallsend in 1902.

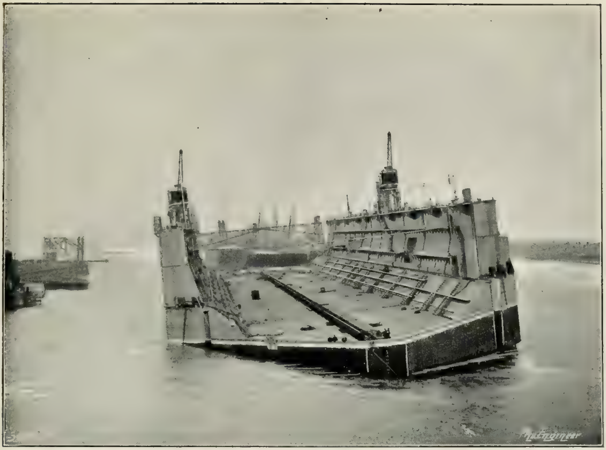
The length of the present Bermuda dock is 545 feet over the keel blocks, its width of entrance 100 feet, and it is capable of normally taking vessels drawing 33 feet of water over keel blocks 4 feet high. The walls themselves are 53 feet 3 inches high, and 435 feet in length, and they form girders of enormous strength. Three pontoons, secured to the lower portions of the walls by fish-plate joints, lugs, and taper-pins, form the bottom or deck of the dock. The middle pontoon is a rectangle 96 feet by 300 feet; the end pontoons, each 120 feet long, taper for 49 feet towards their outer extremities to facilitate towing.

At this immersion the walls have a freeboard of 3 feet 6 inches, which in urgent cases might be safely reduced by a foot or more in order to increase the depth of water over the blocks. Its lifting power up to pontoon-deck level is 15,500 tons, but by utilising the "pound" formed by the bulwark surrounding the pontoon decks, additional lifting power up to 17,500 tons can be gained. The dock, without its machinery, weighs 6500 tons. When called upon to perform its maximum lift the dock is sunk until the summit of its walls is but 2 feet 6 inches above sea-level. Water is admitted into the three pontoons and the two side walls, and from them removed by eight 16-inch centrifugal pumps at a rate sufficient to lift an ironclad of 15,000 tons in three and a half hours. In order that the dock may not tilt as it rises, the whole is divided into fifty-six divisions, each of which is separately connected with the pumps. By turning off cocks, water can be left in any desired divisions, and the dock forced to incline in any direction for purposes of cleaning and repairs. When

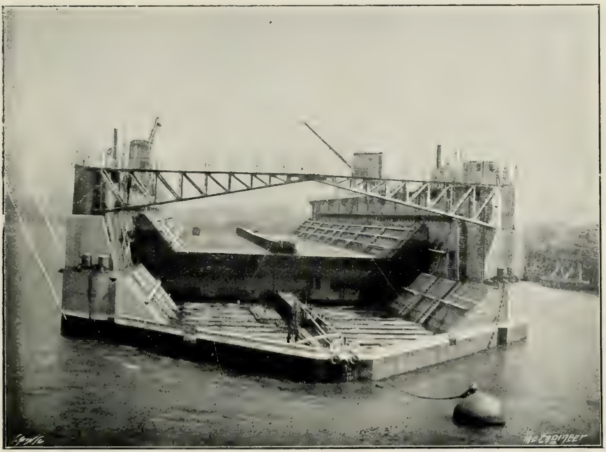
undergoing its official tests the Bermuda dock lifted H.M.S. *Sans Pareil* over 11,000 tons, and after its arrival at Bermuda it received and raised completely out of the water H.M.S. *Dominion*, when that vessel was badly damaged through stranding and was so down in the water as to displace nearly 17,000 tons.

It is specially important that a structure of this kind should be self-docking, that is, able to lift any part of itself clear of the water. To expose the bottom of one side the dock is first lowered to a depth of 20 to 21 feet, the water inside the wall compartments being brought to the same level as that of the water outside. The dock is then raised by emptying the pontoons, and when these are exhausted the water is released from the side to be exposed until the outer corner is two feet or more clear. The pontoons are lifted in turn by withdrawing the pins of one, and allowing it to float, while the rest of the dock sinks. The pontoon is then made fast to the walls at its floating level, and the dock emptied, so exposing the whole of the bottom of the raised pontoon. The two end sections can be treated simultaneously, and floated if required on to the central portion, but the latter must be moved only when the other pontoons are in position. Electric lights and hauling machinery are distributed over the dock. A crane capable of lifting five tons runs along each wall from end to end.

A somewhat similar dock to that at Bermuda, slightly shorter but of greater lifting power, was designed for the Navy Department of the United States of America, and constructed by the Maryland Steel Company at Baltimore, and stationed at Algiers near New Orleans. Its length is 525 feet over blocks, its entrance 100 feet, and its lifting power up to pontoon-deck level no less than 18,000 tons, making it as regards lifting power then the most powerful dock in the world. This lifting could be increased to 20,000 tons by using the " pound." Its hull weight is 5850 tons.



Self-docking of the Bermuda Dock (well heeled).



Bermuda Dock : Centre Pontoon Self-docked

p. 358

It is interesting to note the different methods adopted by the Governments of the two countries for the shoring or berthing of the ships on the dock. The English custom in the case of ironclads of the pre-*Dreadnought* era, and also that of Italy and Japan, is to support the armour belt on more or less vertical shores inserted under an angle-iron firmly attached to the belt.

These shores are put into position as the ship is rising, and, as the water recedes, more and more shores are inserted. The Bermuda dock has large and heavy altars constructed for this purpose. The American custom is to strengthen the bilges of their ironclads with strong bilge docking keels, forming, with the keel proper, a level bottom. No shores are required beyond those necessary to centre the vessel, and no great care is required in adjusting the berth, and one set of bilge blocks does for all sizes of vessels. The American plan affords a great saving in weight and quantity of shores, and, what is more important, a great saving in time, not only in the preparation of the berth and centreing of the ship, but also in the actual lifting. With the American plan it would be perfectly feasible to dock a vessel completely in the time required to centre and adjust her with shores disposed according to English practice.

The Penarth Floating Dock was constructed in 1909 at Wallsend to the order of the Penarth Ship Building and Ship Repairing Company, Ltd. The dock is of the off-shore or single-walled type, and is one of the finest of its kind. It has an over-all length of about 380 feet, an extreme width of 75 feet, and is capable of accommodating vessels having a beam of 55 feet, with a draught of water up to 18 feet, and a displacement of 4200 tons. Its pumping machinery consists of four centrifugal pumps and engines, for which steam is supplied by two large Babcock and Wilcox boilers, working at 160 lb. pressure. This plant can lift a vessel of 7000 tons dead weight in

three-quarters of an hour. For self-docking, the dock is divided transversely into two equal portions, each with its own pumping plant, so that either section can be docked by the other portion. A powerful steam capstan is fitted at each end of the top wall to assist in warping vessels into position when lifting or otherwise. It has eight mechanical side shores in addition to the usual accessories for facilitating the rapid handling of vessels, such as bilge shores, roller fenders, rubbing timbers, and bollards. A duplex reciprocating pump, with a capacity of about 100 tons per hour, has a connection to the main drain of the dock, and enables practically the whole of the water to be pumped out of the dock. On the delivery side the pump is connected to a service-pipe, which has connections at intervals for 3-inch delivery hose. The pump is capable of throwing three jets of water to a height of 40 feet.

To enable this floating dock to enter the wet dock in which it was to work, the entrance to which is several feet less than the width of the dock, a joint was provided running the whole length of the pontoon. On arrival of the dock in Penarth roads this joint was disconnected, and the separate sections towed into the wet dock, and reconnected, and the necessary attachment made to the quay wall.

The Callao floating dock, the towing of which to its destination from the Tyne was the most hazardous towing feat ever accomplished, merits special attention, both on account of the completeness of its equipment and of the extraordinary interest which was manifested in its journey. It is one of the double-sided self-docking type, known as "bolted sectional," and is divided into three separate portions. It is capable of lifting vessels having a displacement of 7000 tons, but it is so designed that this lifting capacity may be increased to 9500 tons at some future period by the addition of a fourth section, making the over-all length

Bolted Sectional Dock Lifting a Vessel.

p. 360

about 510 feet, the present length being 385 feet. Its extreme width, *i.e.*, the clearance between the rubbing fenders, is 70 feet, and the draught over keel blocks is sufficient to take vessels drawing 22 feet. As in previous floating docks built on the Clark and Standfield principle, each section has its own independent pumping machinery and steam-supply. Such usual accessories as keel and bilge blocks, mechanical side shores, rubbing timbers, flying gangways, head capstans, &c., are supplied, and there is also a heavy mooring outfit of anchors and cables. The dock was launched in June 1908, and at that time satisfactorily completed a self-docking trial by lifting one of the end pontoons alongside the Wallsend shipyard. For this purpose the three sections of the dock were disconnected, and the two end sections were turned round end for end, so that their points came opposite to the central section which is square-ended. They were then lowered under the water and drawn in under the central section. On pumping out the end sections they rose, bringing up with them the central section, which was then resting on their pointed ends. The dock left the Tyne on August 20 of that year, in charge of the powerful Dutch tugs *Roodezee* and *Zwartezee*, each of which has an indicated horse-power of 1500, their bunker capacity being 650 tons and 600 tons respectively. The dock in its journey to Callao was manned by a captain, mate, engineer, and nine sailors.

It was fastened to the tugs by extra superior Manila ropes of 18 inches, with 30 fathoms of flexible steel wires of 4½ inches circumference on both ends, while each tug had on board a new spare rope of precisely the same size and quality. One tug broke down on the way, and another had to be sent to Monte Video to take her place.

The time taken on the journey was 225 days, but after deducting the delays in the Thames and at Monte Video, the time occupied on the passage was only a little over four months.

The long voyage down the Atlantic, culminating in the passage of the dreaded Straits of Magellan, caused the vessel to be kept upon the marine reinsurance list almost from start to finish.

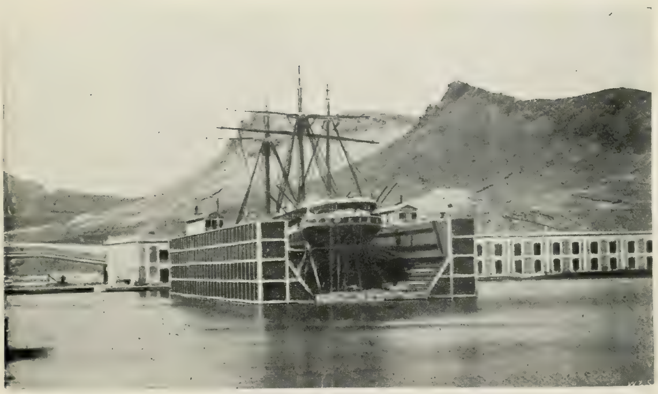
The distance from the Tyne to Callao does not represent a world's record for a tow of this nature, inasmuch as it has been exceeded by the Dewey Dock built by the Maryland Steel Company of Baltimore for the United States Government, which, in the summer of 1906, was towed from America to the Philippines, a distance of 13,089 miles, in 150 days.

Great Britain, though a large builder and the principal designer of floating docks, does not possess very many; possibly the number and excellence of the dry docks scattered round her coasts may be the explanation. But as dry docks are costly to make or alter, the British Admiralty has ordered the construction at Wallsend of a floating dock which will take the largest battleship afloat or likely to be built for some years to come. In anticipation of the possible needs of the mercantile marine, plans have been prepared for a floating dock with a lifting power of 45,000 tons.

The largest floating dock in existence at present is at Hamburg, which has a better equipment in this respect than any other port in the world. It was built by Messrs. Blohm and Voss, the shipbuilders, for their own use, and was completed last year and can lift 35,000 tons. Hamburg has altogether eighteen iron and steel floating docks. Bremen has three large floating docks, two of which, if used together, have a lifting power of 3300 tons. The third dock, 385 feet long by 83 feet inside measurement, can lift a vessel of 10,500 tons.

Other countries also have provided themselves with floating docks; indeed there are few nations of any importance which have not several floating docks, modern in type, of great lifting power, and thoroughly equipped. A

THE "BAIKAL"



THE CARTAGENA DOCK.

p. 362

few, like Austria, reserve the docks for naval purposes only.

The life of the iron or steel floating dock of whatever type is likely to be far longer, if care be taken of the structure, than might at first be supposed. Rennie's Cartagena dock, built of iron in 1859, was in such splendid condition when the proposal was made to build a Havana dock that as a counter-proposal it was suggested to send the Cartagena dock there. The *Nicolaieff*, built in 1876, has been uninterruptedly employed ever since in lifting the vessels of the Russian Navy. The Victoria Dock is 310 feet in length, and of the hydraulic-lift type, with a lifting power of 3000 tons, and has nine pontoons or trays of a total length of 2185 feet, and an aggregate lifting power of 17,060 tons; the pontoons were constructed between 1857 and 1876, the largest of them being of 5000 tons. The Malta dock, also of the hydraulic type, is 340 feet in length, with a lifting power of 4000 tons, and was built in 1871. It has two pontoons of 4000 and 2500 tons respectively. The hydraulic floating dock at Bombay, built in 1872, was rather larger, being 400 feet in length with a lifting power of 8000 tons, its pontoon of the same length lifting 6500 tons. These lifts were designed by the late Edwin Clark, M.I.C.E., who introduced floating docks from which the present types have directly sprung. These hydraulic docks are no longer at work.

The carrying of railway trains by ferry-steamers across stretches of water too large to be bridged over is no new thing, there being several such in the United States and Canada. Many of the vessels thus employed are of considerable size. These waters are comparatively landlocked, and the traffic, except in unusually stormy weather, is seldom interrupted. The American ferry-boats are double-ended, so that a train can enter at one end and leave at the other after crossing the water, the ends of the ferry-boat and of the pier supporting the shore lines being constructed to fit

exactly. Most of the modern American ferry-boats taking railway trains have two, three, or four sets of rails on their decks, and accommodate their passengers on a deck above, where the saloons and cabins are situated. Where the railway-level is different on the two sides of the water, the boat or the landing-stage is provided with hoisting machinery which raises the train to the desired level, a truck or two or a passenger coach at a time.

The nature of the work these railway ferry-steamers have to perform, and the fact that every one has to be built to suit the special conditions of the ferriage where it is to be employed, make it inevitable that no two of them are alike, except such as may be sister vessels employed on the same station. In Russia the conditions are very difficult. The current of the River Volga is swift, the height of the water-level varies as much as 45 feet, and as the ice is frequently two feet in thickness the work of maintaining the ferry is not to be undertaken lightly. The vessel by which the service is performed was built by Messrs. Armstrong, Mitchell and Co. To enable it to be sent to its destination it was constructed in four parts, so that it would pass through the Marinsky Canal to get to the Volga. The boat is 252 feet long by 55 feet 6 inches broad, and 14 feet 6 inches deep. It has four lines of rails, converging at the bow into two, and altogether can accommodate twenty-four trucks. At the bow is a high framework for a hydraulic hoist which lifts the trucks between the deck and the rails ashore, a distance of 25 feet, the difficulty of negotiating the remaining portion of the difference in the level being overcome by there being two levels of rails on the landing-stage. The propelling machinery, of the surface-condensing type with twin screws, gives the vessel a speed of nine knots an hour. The bronze propellers are unusually strong and heavy to withstand blows from the ice in the river ; the actual ice-

breaking to keep the passage clear is performed by another steamer.

A ferry-steamer of a different type is that which plies across Lake Baikal in Central Asia in connection with the Transasiatic Railway. As the lake is frozen over for nearly half the year and the vessel has to do duty as an icebreaker as well, the hull has been made extraordinarily strong and heavy. The stem and stern are of massive steel castings. The vessel, which is of steel throughout, is 290 feet in length by 57 feet beam, and the draught of water is rather over 18 feet. The hull bears an outer plate an inch thick and 9 feet wide, placed from end to end along the water-line as a further protection against the friction of the ice. The vessel is also subdivided extensively into water-tight compartments in addition to the usual bulkheads. Over the railway deck are large and sumptuous public and private staterooms. Three sets of triple-expansion engines have been installed with boilers working at a pressure of 160 lb.; there are twin propellers at the stern, and a third propeller at the bow.

This vessel is also remarkable as being probably the most rapidly constructed vessel of her size in existence. Not six months elapsed from the time the order was received until the steamer was built, unbuilt, and packed on board a steamer ready for departure to Russia, this including also the making of the engines. The packages were conveyed as far as possible along the Siberian Railway and thence by sledges to Lake Baikal, where the ship was re-erected.

The only sea-going railway ferry-steamer in existence is the *Drottning Victoria*, launched in January 1909 from the Neptune Works of Messrs. Swan, Hunter, and Wigham Richardson, Ltd., to the order of the Royal Administration of the Swedish State Railways. She was built to ferry trains across the Baltic, between Sassnitz in Germany and Trelleborg in Sweden, a distance of 65 nautical miles. High sea-going qualities were necessary as the voyage is

occasionally a very rough one. The vessel is 354 feet in length by over 50 feet beam, and is propelled by twin-screw triple-expansion engines, supplied with steam from four large boilers working under Howden's system of forced draught. The trains are carried on two tracks on the car deck, occupying nearly the whole surface of the deck. Above and below this deck is very luxurious passenger accommodation. The vessel has been designed to be very steady at sea, and has unusually large bilge keels fitted to minimise the rolling. Spring buffers and other necessary appliances are arranged to prevent the cars from moving when at sea. A bow rudder is fitted as well as the stern rudder, and both are controlled by steam from the captain's bridge. The steamer has been divided into a very large number of water-tight compartments, which, with the bulkhead doors with which she is fitted, render her practically unsinkable. She is also to be fitted with a submarine signal installation. The ventilating and heating are ensured by an installation of thermo tanks, enabling fresh, warm air to be forced into all the rooms in winter and fresh cool air in summer. Her speed is over 16 knots per hour, and the journey is made within four hours.

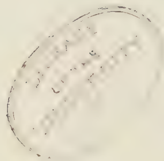
The performances of this boat are being watched with no small amount of interest, as it has been suggested that if she should prove equal to all requirements a modification of this form of steamer might be successful in the cross-Channel service between Dover and Calais, or other ports on either side of the English Channel.

Ferry-boats of other types exist by the score, from barges upwards, propelled by an extraordinary assortment of contrivances, some of the older and quainter of which have been referred to in an earlier portion of this book. The historic Tyne ferries were withdrawn not long since for financial reasons, but an attempt is being made to restart them. The ferries at Glasgow and over the Mersey have each their own special features, and even the Thames

Photo. Frank & Sons, South Shields.

The "Drottning Victoria."

p. 366



has not always been without penny steamers. The Thames Steamboat Company and other organisations have made the experiment. The later effort of the London County Council to establish a service deserved a better fate, for the boats were well built and the engines were compact and powerful for their size.

The necessity of keeping open waterways which Nature wishes to close annually by freezing over, led to the invention of a species of vessel planned with that object. The most famous ice-breaker is the *Ermack*, launched in 1899 by Messrs. Armstrong, Whitworth and Co. for the Russian Government, for which she was designed by Vice-Admiral Makaroff. Many of the harbours of northern Europe are frozen over for the greater part, and sometimes the whole, of the winter, to such an extent that the ice attains a thickness of several feet; and navigation is at a standstill so far as those ports are concerned. The only way of keeping a channel open is to prevent the ice from freezing too thickly to permit of the passage of vessels, and this is done by keeping a vessel moving frequently up and down the channel to break the ice before it can freeze so thickly as to become impassable.

An ice-breaking ship, to perform its allotted task, must be both weighty and powerful, and capable of travelling at a speed sufficient to give her the required momentum so that she may break the ice by the sheer force of the blow she delivers when she rams it, and she must be strong enough to inflict and not sustain damage by the collision. Further, besides cracking the ice into fragments weighing a few score tons apiece, she must be able to slide upon the ice and crush it by sheer weight. The *Ermack* is 305 feet long, 71 feet beam, and 42 feet 6 inches deep. She had three screws aft and, when first built, had a fourth screw forward, the forefoot being considerably cut away to allow it to operate between the stem and keel. The idea was that the forward screw would agitate the water under the

ice about to be struck and thus lessen the support the ice received from the water, and that it would also prevent an accumulation of ice under the ship's bottom by creating a current of water towards the stern where the after propellers would throw the ice astern of the ship. This screw was found to be less useful than was expected, or rather it was discovered in practice that as good results could be obtained without it as with it in dealing with the massive Arctic ice, or any ice over a certain thickness, and when the ship was sent back to her builders a few years later to be lengthened, the forward propeller was taken out and not replaced. When the alterations were made the bow was severed in dry dock, and another bow having been built it was launched and floated into the dock and attached to the vessel. This bow is of a different shape from the other and has proved to be even more effective than the old one. Three screws aft are necessary in an ice-breaker of this size in order to give the power for the proper performance of her duties and also to enable her to be steered in very limited areas, greater steering facilities being obtainable by this means than by any other. The *Ermack* is fitted with three sets of triple-expansion machinery, having cylinders 25 inches, 39 inches, and 64 inches diameter, with a 42-inch stroke of piston, working at a pressure of 160 lb. The boilers are six in number, 15 feet in diameter by 20 feet long, working under forced draught. The machinery develops about 10,000 horse-power.

One of the *Ermack's* feats was to rescue the coast defence armour-clad *General Admiral Apraxine*, which had got frozen in after stranding in the Baltic.

She finds no insuperable difficulty in smashing her way through ice 12 or 13 feet in thickness. The first piece of ice she ever attacked was drift ice about five feet thick, through which she went easily with her engines giving her little more than half-speed. The most serious test was against ice estimated at 25 feet thick, consisting

of 5 feet of field ice, 9 feet of pack ice above it, and ice 11 feet thick, and perhaps more, below the field ice. Thick snow on top of thick field ice forms the most serious obstacle, the snow forming an immense cushion or ridge which becomes worse the more an effort is made to get through it. On another occasion she made her way by ramming through ice 34 feet in thickness. Another experience was to rescue eight of nine steamers which were nipped in the ice; the ninth was so badly squeezed by the ice that she sank before the *Ermack* could force her way to her.

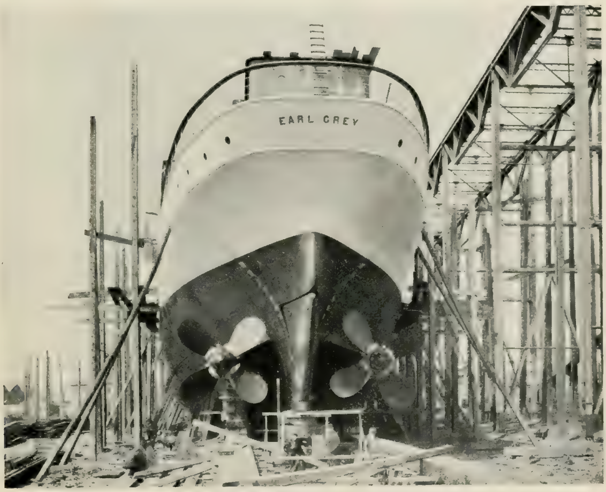
A smaller ice-breaker, the *Sampo*, built by the same firm for Finland, has gone through sheet ice 12 inches thick at a speed of 8½ knots, and frequently through drift ice 10 or 12 feet thick.

On the other side of the Atlantic, whenever a severe winter is experienced, many of the Canadian and United States lake and coast ports are only kept open by means of ice-breaking ferry-steamers. Of the latter type is the *Scotia*, built by Armstrong, Whitworth and Co. for the carriage of railway trains across the Straits of Canso to and from Port Mulgrave, Nova Scotia. She is 282 feet in length, and on the rails laid on her decks she is capable of taking a load of nine Pullman cars, and can also accommodate an express locomotive and tender weighing as much as 118 tons. She has an ice-breaking propeller and a rudder at each end, and has two sets of triple-expansion engines of 1200 horse-power each. Her speed is rather over twelve knots.

About four years ago the ice-breaking and surveying steamer *Lady Grey* was launched by Messrs. Vickers, Sons, and Maxim at Barrow-in-Furness for the Canadian Government, and performed some exceedingly effective work, particularly in the St. Lawrence River or in duties associated with the Marine and Fisheries Board. A larger and faster vessel being required, the builders were asked

to provide a steamer which, while preserving all the qualities of an ice-breaker, should yet be able to attain a speed of seventeen knots, and be capable of use for a variety of purposes. The *Earl Grey* was launched in June 1909, and besides fulfilling these requirements has been engaged in the passenger traffic across the Northumberland Straits. She has been fitted with special quarters, enabling her to be employed as an official yacht by the Governor-General. Provided with a cut-water or schooner stem with a short bowsprit, an elliptical stern, and two steel pole schooner-rigged masts, which rake considerably, and having been designed with a graceful sheer, she has more of the appearance of a large yacht than an ice-breaker intended to be able to make her passages in all sorts of weather and under widely varying conditions. The hull is built with extraordinary strength ; the frames are very closely spaced in order to take up the thrust of the pack ice which in winter may sometimes be piled round the vessel; the shell plating is of unusual thickness, and the outer skin is double right fore and aft along the water-line and to the bottom of the keel in the fore body, where the friction of the ice tends in the case of ice-breaking steamers to wear away the material. The ordinary practice of this and all other ice-breakers, in whatever part of the world, is to utilise their weight to break the ice by rising upon it and crushing it. In order to possess as great a weight as possible, large tanks are built into the fore part of the *Earl Grey* which can be filled or emptied at a rate of 250 tons an hour. The vessel is also equipped for breaking ice when going astern, the counter having been suitably strengthened to resist the shocks ; while to secure the rudder from injury it has been built into the form of the ship so that her movements are not impeded by the ice-floes. The *Earl Grey* is 250 feet in length, 47 feet 6 inches beam, 17 feet 7 inches depth, and 3400 tons displacement. She has accommodation for fifty first-class

THE "ERMACK."



THE "EARL GREY."

p. 370

passengers and twenty in the second class, and under these circumstances winter ice-breaking excursions may yet become the vogue among those in search of a new sensation.

The introduction of steam-propelled vessels was objected to by sailing-yacht owners, but the advantages of auxiliary power in yachts intended for cruising overcame all opposition, and in the course of a few years the number of yachts of all rigs, even cutters, fitted with auxiliary power, steadily increased. Machine-driven yachts are intended as cruisers. A few steam-yachts had paddle-wheels, the latter being specially favoured for all vessels intended for Government or for Royal use, where sea-going qualities were required. One of the most notable of this type was the *Victoria and Albert*, built to the order of her Majesty the late Queen Victoria, which was, at the time of her launch, one of the finest yachts afloat. Among the earliest of the Royal yachts was the screw steamer *Fairy*, which was built for the late Queen in 1845 at the Thames Iron Works, Shipbuilding and Engineering Company's yard at Blackwall, then owned by Messrs. Ditchburn and Mare. This was the first iron vessel owned by the British Government. Her dimensions were: length 144·8 feet, breadth 21 feet $1\frac{1}{2}$ inches, draught 6 feet, displacement 210 tons, horse-power 416, and speed 13·21 knots.

It is only fitting that the finest Royal yachts afloat intended purely for pleasure purposes should be at the disposal of the monarch of the leading maritime nation, and the latest Royal yachts built for the late King Edward merit this description. They are the present *Victoria and Albert* and the *Alexandra*, the latter built in 1908. Other modern Royal yachts of note are the German Emperor's *Hohenzollern*, which is heavily armed and can be utilised as a fast cruiser if necessary, and the Russian *Pole Star* and *Standart*.

Amongst the celebrated Royal yachts of the past belonging to foreign rulers are the iron paddle-steamer *Faid Gihaad*, built in 1852 by Messrs. Ditchburn and Mare for Said Pasha, the then Khedive of Egypt. She was a flush-decked barquentine, 285 feet in length between perpendiculars, 318 feet over all, with a breadth of beam of 40 feet and a tonnage of 2200. Her engines were of 800 horse-power and were built by Messrs. Maudslay and Field. She was equipped as a war vessel and carried an armament of two 84-pounder pivot guns, twelve 32-pounder broadside guns on the upper deck, and fourteen 32-pounders on the main deck. Like everything else that the Pasha indulged in, the *Faid Gihaad* illustrated his taste for luxury. Externally the vessel was painted white from the water-line, below which she was copper-coloured. The stern was ornamented with a gold scroll, and each paddle-box had a crescent and star in gold. Three years before the building of the *Faid Gihaad* there was constructed at Alexandria, by order of Said Pasha, a steam-frigate called the *Sharkie*, which was sent to this country to be fitted with steam-engines and a screw propeller. She was 220 feet in length, was rigged as a second-class frigate, and had engines of 550 horse-power by Miller and Ravenhill. These were capable of driving her nearly 11 knots an hour. Her armament consisted of 36 guns of heavy calibre. The furniture and panelling of the cabins were richly inlaid with ivory and mother-of-pearl, which may have admirably suited the taste of Said Pasha in these matters, but can hardly have conduced to the efficiency of the vessel as a fighting machine.

In the days when the Papal States were a power in the land and his Holiness was not a voluntary prisoner in the Vatican, the then occupant of St. Peter's chair was the possessor of a very fine armed screw steam-yacht, the *Immacolata Concezione*. She was built by the Thames Iron Works and Shipbuilding Company, with engines by Messrs.

Photo. G. West & Son.

THE ROYAL YACHT "VICTORIA AND ALBERT."

Photo. G. West & Son.

THE IMPERIAL YACHT "HOHENZOLLERN."

p. 372

J. Seaward and Co. of Millwall. She carried eight brass 18-pounder guns, and was a three-masted full-rigged ship of some 627 tons burden. The engines were of 160 nominal horse-power and 300 indicated, and were capable of giving her a speed of 13 knots an hour.

Among other famous iron vessels which were either specially built or employed as Royal yachts in the middle of the last century may be mentioned the *Jerome Napoleon*, constructed by M. A. Normand at Havre for the late Prince Napoleon, afterwards Emperor of the French; the *Peterhoff*, built by Messrs. Ditchburn and Mare at Blackwall in 1850 for the late Emperor Nicholas of Russia, which was wrecked on her outward voyage to the Baltic; the *Falken*, built at Deptford in 1858 by Messrs. C. Langley for the late King Frederick VII. of Denmark. She was an iron schooner-rigged vessel 127 feet in length, and could steam at 10 knots an hour. The *Miramar* was a favourite yacht with the late Empress of Austria. The Russian Imperial Yacht *Livadia* was circular and shallow, and is the only large turbot-shaped yacht afloat. These yachts, however, have been gradually superseded by vessels of a thoroughly modern type. As a case in point, the *Princess Alice*, owned by H.S.H. the Prince of Monaco, and constructed by Messrs. R. and H. Green at Blackwall in 1891, is built of steel frames with teak planking, her bottom being covered with copper sheeting. Thus in her general finish she is one of the finest specimens of marine architecture on the composite principle which ever took the water. Unlike most Royal yachts, she is used not merely for pleasure but also for scientific research, for the Prince of Monaco is well known for his contributions to the scientific knowledge of ocean depths and all that pertains thereto. The expeditions which he has organised, and most of which he has conducted in person, are invariably made on this yacht, which is splendidly equipped for the purpose. In order that she may be able to cover a large radius of action,

she is fitted with an unusual coal capacity and can store in her bunkers sufficient to carry her 3700 miles. Under steam alone she can make 9 knots an hour, and with steam and sail combined she has been known to attain to nearly 12 knots an hour.

The *Safa-el-bahr*, designed and constructed in 1894 by Messrs. A. and J. Inglis of Glasgow for his Highness the Khedive of Egypt, is also a steel-built two-decked yacht. She is schooner-rigged, and is fitted with three-stage expansion engines with cylinders 18 inches, 29 inches, and 48 inches in diameter, giving a piston stroke of 36 inches. These are supplied with steam at a pressure of 160 lb. from two boilers having a heating surface of 2300 square feet, and give an indicated horse-power of 1200, with a speed of 14·1 knots per hour. Her tonnage under yacht measurement is 677 tons. She has a length of 221 feet, breadth 27·1 feet, depth 17·3, with a draught of 12 feet.

As private yacht-owning is a pastime in which only the wealthy can indulge, and as almost all private yachts are built to suit the fancy of their owner, a considerable individuality is displayed by them. They range in size from vessels not bigger than a ship's boat to ocean-going liners. The *Winchester*, the latest boat of her class yet devised, is a triple-screw turbine yacht, bearing a strong resemblance to a torpedo boat. Her dimensions are: length 165 feet, breadth $15\frac{3}{4}$ feet, depth $9\frac{3}{4}$ feet, and displacement 180 tons. She was built in 1909 for Mr. W. P. Rouss, a prominent member of the New York Yacht Club, by Messrs. Yarrow and Co. of Scotstoun. The propelling machinery consists of three Parsons marine steam turbines constructed by Messrs. Yarrow. She has two Yarrow water-tube boilers, and her furnaces are fitted to burn oil fuel. The hull is of steel. At her trials at Skelmorlie she easily maintained a speed of $26\frac{3}{4}$ knots, which was $\frac{3}{4}$ of a knot in excess of the speed stipulated in her building

contract; and it was believed that a much higher rate could have been achieved, as 250 lb., the full working pressure of her boilers, was not reached, the high pressure of her high-power turbine being only 160 lb.

The *Iolanda*, of about 2000 tons yacht measurement, was built for an American owner in 1908, and was then stated to be the second largest privately owned yacht in the world. She was both constructed and engined by Messrs. Ramage and Ferguson, Ltd., Leith. Her length over all is about 305 feet; beam 37 feet 6 inches; depth 23 feet. Her twin-screw machinery is of the triple-expansion four-crank type of 3000 to 4000 indicated horse-power. Her boilers are partly cylindrical marine return tubular and partly water-tube. This combination, the first installed in any yacht, affords the advantage of being able to raise steam and get under way at practically a moment's notice, or provides additional speed at short notice when required, while the bunker capacity of some 550 tons gives the yacht a very extensive ocean-steaming radius. She is provided with motor and steam launches, quick-firing guns, electric-lighting apparatus, which is accredited as being the largest ever installed in a private yacht, and includes arrangements for manipulating the Marconi wireless telegraphy.

Among eccentricities of design in steamboats may be mentioned cigar ships, vessels shaped like birds, early submarines, double-hulled boats, and numerous other extravagances. One of the earliest submarines was contrived by a Dutchman named Hollar, about 1653, but whether this wonderful vessel ever got beyond the imaginative or paper stage is unknown. There is a picture of it in the British Museum. This singular craft was to be 72 feet in length, 12 feet high, and 8 feet beam, with a wheel in the centre where it "hath its motion." The description says it was built at Rotterdam. The inventor undertook in one day to destroy 100 ships. "It can go from London to Rotterdam and back in one day, and in six days can go to the

East Indies, and can also run as fast as bird can fly." "No fire, no storm, no bullets can harm her unless it please God." There is no further trace of her.

The first submarine which achieved any measure of success was that of David Bushnell, an American, who devised it in the hope of blowing up a British warship and failed egregiously. Bushnell, who was born at Saybrook, Conn., in 1742, devoted a large amount of attention to submarine warfare. His idea was to fix a small powder magazine to the bottom of a vessel and explode it by means of a clockwork apparatus. He constructed a tortoise-shaped diving boat, made of iron, and containing sufficient air to support a man for half an hour. This boat, called the *American Turtle*, was propelled by a sort of screw or oar worked from inside. It could be immersed by admitting water through a valve in the bottom, and lightened by pumping the water out again. She was tried, without success, against the British warship *Eagle* in New York harbour, and a later attack on the *Cerberus* left that frigate unharmed, but blew up an American schooner and some of her crew.

The *Gemini* twin steamer, invented by Mr. Peter Borrie, was a double-hulled boat, launched in the summer of 1850. The keels and stems were not placed in the centre of the hulls but towards the inside of them, thus making the water-lines very fine on the inside. This was intended to diminish the tendency of the water to rise between the hulls. The inner bilges were much fuller than the outer ones, the idea being to afford a greater degree of buoyancy on the inside, in order to support the weight of the deck. The steamer was 157½ feet long over all, and 26½ feet broad on deck. Each hull was 8½ feet broad, with a space 9½ feet between them. The frames were of angle iron, and the keels were formed by carrying the plates downwards, so as to form channels for the bilge-water inside the hulls. This arrangement was intended

for river craft of this type, but for sea-going vessels drawing more water the inventor planned keels of iron bars, with the garboard-strakes riveted upon them in the customary way. The plating was not carried to the top of the frames on the inner side of the hulls, except at the space in the middle for the paddle-wheel, but was carried up to the deck, thus forming an arch between the two hulls, which were bound together with stays. The hulls were divided into water-tight compartments. The vessel was two-ended and could travel in either direction without turning. There was a rudder at each end, placed in the centre of the opening between the two hulls. It was constructed somewhat in the manner of the balanced rudder of later years, as it was affixed to a vertical shaft in such a way that it was divided into two unequal parts, and when left free would accommodate itself to the vessel's motion. The steamer was estimated to carry from 800 to 1000 passengers.

Whether in the sailing days or since, the crossing of the Channel between Dover and Calais has been attended with an amount of misery altogether disproportionate to the shortness of the voyage. It is therefore not surprising that inventors have at one time and another attempted to design vessels which should give the maximum of speed and comfort and the minimum of sea-sickness. The English Channel Steamship Company, Limited, was formed in 1872 to adopt the plan of a steam-ship designed by Captain Dicey, and construct the steam-ship *Castalia*. His idea was that two large hulls should be used, and placed at such a distance apart that each should act as an outrigger to the other, and the whole structure should remain comparatively steady. The *Castalia* was built by the Thames Iron Works Company. She was 400 feet long, and each hull had a beam of 20 feet, with a depth of hold of 20 feet. The distance between the two hulls was 35 feet, and they were united by strong girders. The hulls were

very sharp at the ends, and flat in the floors, and the draught of water was only 6 feet. The inner sides of the hulls had a freeboard of 14 feet, and the uniting girders were slightly arched, but a difference in the methods of fixing them to the hull was made, compared with previous experience with double-hulled vessels. In former attempts to solve the problem of the navigation of twin steamers, the connecting beams had usually been placed in such a way that their ends extended under the decks of the hulls. This in the case of wood was manifestly a plan which did not permit of a very large vessel or of a certain limit of strength being exceeded. Captain Dicey's scheme in adopting the arched form of girder was to utilise to the utmost the strength of the iron, and bind with the utmost rigidity the whole structure together. Where the girders entered the hulls the upper part was just under the deck; the girders were carried right across to the outer sides of each hull, additional strength being provided by bolting every girder to a bulkhead. The space between the hulls was decked over, and allowed ample accommodation for passengers. Each hull carried a powerful engine for driving a large paddle-wheel, the wheels being placed with a space between them amidships between the two vessels. The vessel could be steered at either end, thus obviating the necessity of turning, and a navigating bridge extended across the tops of the two paddle-boxes. It was even claimed that the ship would be large enough to carry railway trains across the Channel, but this does not seem to have been tried. As she drew only a trifle over 6 feet of water she could enter the harbours on either side of the Channel at any state of the tide, and though she was steady enough as a sea boat she was too slow, and was withdrawn from service.

A double-hulled boat of a somewhat different type, and from which great things were expected, was the *Calais-Douvres*. Her principal features were to be an

increase in speed and stability, and by means of the steadiness of her double hull, the abolition of sea-sickness. She was an enlarged *Castalia.* The expectation of her owners on these points was not realised and after a few trips she was withdrawn from service and replaced by another and more efficient vessel of the ordinary type.

To the category of magnificent failures there should be added the steam-ship *Bessemer,* launched at Hull in 1874 and designed by and named after Mr. (afterwards Sir) Henry Bessemer. The object her designer had in view was to mitigate the horrors of the cross-Channel passage, and to accomplish this he fitted his boat with a spacious saloon which, by means of a series of pivots and a gyroscope, would remain in a level position without oscillation, no matter how much the vessel might roll or how rough the weather might be. These arrangements worked perfectly in theory, but immediately the *Bessemer* went to sea for her trials and the test became a practical one, it was discovered that she must be relegated to a conspicuous place among the successes that might have been. Everything about her was on a lavish scale. A peculiarity was that she had four paddle-wheels, two a side, an experiment that has never been successful. Her form also was against her, and in dirty weather she would have been a wet ship, difficult to steer, and almost helpless.

On her private trial trip the *Bessemer* attained a speed of eleven knots in crossing from Dover to Calais, but was thirty-five minutes in getting alongside the French pier.

One of the most extraordinary vessels ever designed was that known as the *Connector.* She was not rigid, but was built of sections which could be joined together, so that she would bend in accord with the motion of the waves. The joints were constructed by giving to the after end of all sections (but the last) a concave form so that it would overlap the convex bow of the adjoining

section. These were joined and hinged by massive iron bolts resting in stout wrought-iron sponsons built into the ship's sides and framework. If necessary one of the sections could be disconnected and the other three joined up. As each section was fitted with a fore and aft rig, like a cutter, it could make its way under sail alone if necessary. The engine was contained in the hindmost section, which really pushed the other three along. She was intended to be used as an iron screw collier in the London and North-East coast coal trade. Each section was to act as a lighter, and could be left where desired, while the others were sent to their respective destinations, to be picked up again in turn when it was desired to reunite the vessel, and send her for another cargo. The advantage claimed for this peculiar system was that vessels of very light draught, and of length far greater than hitherto and carrying the largest cargoes, might be used without the danger of breaking their backs, or even straining, the yielding of the joints neutralising that liability; also that their great length, light draught, and narrow midship section, permitted unprecedented speed, while the facility for detaching part of the vessel in case of collision, fire, sudden leakage, or grounding with a falling tide, would afford a means of saving life and a portion of hull and cargo, when otherwise all would be lost. A company called the Jointed Ship Company was formed to exploit this novelty in ship construction. Like other experimental schemes it was not a success, the theory of the designers and the practice of Father Neptune not being in accord.

The *Winans* cigar ship, as her name indicates, was shaped like a huge cigar. Messrs. Winans began experimenting in the 'fifties at Baltimore with a view to ascertaining the amount of water-friction sustained by surfaces of differing smoothness at various speeds, the relative resistance of proportions and speeds, and whether any advantages were to be gained from spindle-shaped vessels as compared

with ordinary vessels. These experiments resulted in the launching in October 1858 at Ferry Bay, Baltimore, of a spindle- or cigar-shaped vessel having about its middle a ring bearing flanges set at an angle calculated to strike the water and propel the vessel. She had four powerful engines placed amidships, and rudders at both ends measuring 4 feet by 3 feet. She was 16 feet in diameter at the widest part and 180 feet long, and it was expected she would cross the Atlantic in four days; she belied those expectations. The owners stated that she was designed "to obtain greater safety, despatch, uniformity, certainty of action, as well as economy of exportation by sea." They believed that "by discarding sails entirely, and all the necessary appendages, and building the vessel of iron, having reference to the use of steam alone, these most desirable ends may be even still more fully attained than by vessels using both sails and steam." They continue: "The vessel we are now constructing has no keel, no cutwater, no blunt bow standing up above the water-line to receive blows from the heaving sea, no flat deck to hold or bulwark to retain the water; neither masts, spars, nor rigging." The plan and position of the propelling wheel were supposed to be such that its minimum hold of the water would be much greater in proportion to tonnage than the maximum hold of the propelling wheel or wheels in ordinary steamers. The engines were high pressure with a cut-off variable from one-sixth to full stroke; combined, they were to exert threefold more power in proportion to displacement of water than those of the most powerful steam-packets then built. Her boilers were of the locomotive type, consuming 30 tons of coal in twenty-four hours, the smoke, &c., being carried away by two funnels. She was divided into several water-tight compartments. With 200 tons of coal on board she was to displace about 350 tons of water, and accommodate about twenty first-class passen-

gers and the United States mail, with room to spare for small valuable packages, specie, &c. The same principles and properties which were to adapt the vessel to high average speed were claimed to be also adapted to the cheap, safe and sure transportation of freight as compared with vessels using sails only or sails and steam combined. There was a railed-in space on her upper surface for the deck.

Messrs. Winans' first cigar ship, though not fulfilling all the hopes formed of her, was, on the whole, sufficiently successful to encourage the continuance of the experiments, for in the two following years she was severely tested both for speed and seaworthiness in all sorts of weather. Another vessel was built at St. Petersburg in 1861 with a submerged screw propeller at the stern, which gave so much more satisfactory results than the revolving belt apparatus that Messrs. Winans were encouraged to order a third spindle ship. This was built by Mr. John Hepworth of the Isle of Dogs, and was named after her inventor, Mr. Ross Winans. This boat was 256 feet in length with a diameter and depth of 16 feet, and was circular in form throughout. The top of the vessel was strengthened for 130 feet amidships by four longitudinal ribs of steel which supported the deck, and also rendered the top as strong to resist tension and other strains as the bottom. Internally there were iron ribs running round the vessel 4 inches deep and 3 feet apart in the engine and boiler room, and 7 inches deep and spaced 6 feet elsewhere. The bottom and side plates were of iron, were thicker amidships than at the end, while the bottom was further strengthened and protected outside the skin plates by a plate of iron 1 inch thick and 33 inches across at its widest and diminishing to a point at the ends. The skin plates of the top were of toughened steel $\frac{3}{8}$ inch thick amidships. The two screw propellers, one at either end, were 22 feet in diameter and were only half immersed in the

water, though it is difficult to imagine what advantages were supposed to be gained by incomplete immersion, seeing that the exposed part represented so much dead weight to be carried, to say nothing of the other drawbacks. A space 48 feet 6 inches long amidships was devoted to the engines and boilers. Each of the four boilers had a fire-box, and was surmounted by two vertical cylinders containing vertical tubes; while the centre portions of the boilers were tubeless to allow of more ready cleaning and a better circulation. A fan increased the draught and also the ventilation of the ship. The engines were surface-condensing. The problem of allowing the longest possible stroke was ingeniously solved. Above each of the three jacketed steam cylinders was a shaft, carrying two cranks and working by the sides of the cylinder, the piston-rods passing the shaft and connecting with a cross-head above, which was connected with the cranks by two rods. The three engines were joined by a system of return cranks and a peculiar coupling, which prevented cross-strains from the transmission of power from engine to engine, and from the shafts of the different engines getting out of line. The ship could carry coal for twelve days at normal consumption. On deck it carried two masts and two funnels, all having a considerable rake aft.

In 1860, Captain George Peacock, F.R.G.S., formerly a London merchant, and then residing near Exeter, invented a yacht in the shape of a swan. Her title, the *Swan of the Exe*, was displayed on a banneret, the brass rod of which was held in the swan's beak. This mechanical bird was 17 feet 6 inches in length, with a maximum beam of 7 feet 6 inches, and its height from the keel to the top of the back was 7 feet 3 inches. Its neck and head, which were gracefully curved, rose 16 feet above the water. Its long neck had to do duty as a mast for supporting by means of halliards the two wings, each of which consisted

of a double lateen sail. The halliards passed through gilt pendant blocks, attached to a ring, fastened round the neck just below the head. The vessel itself consisted of twin boats beneath the water-line, there being an oblong compartment in the centre, though viewed from the front or side it appeared to consist of one hull only. She had two powerful webbed and feathering feet, constructed of steel, to propel her. These were placed between the keels or hulls, and worked by a lever attached to a contrivance such as is seen on old-fashioned hand fire-engines, operated by two or four persons as required. With two oars which she could also carry, her fishtail-shaped rudder, her feet, and her wings, she could get up a speed before the wind of five miles an hour. She was only intended for ornamental waters or inland lakes. Her interior fittings suggested those of a first-class railway carriage, with plate-glass windows at the sides, &c. Her centre table was big enough for ten persons to dine comfortably at, and at night it could accommodate a mattress upon which to sleep. A description of her at the time adds: "In the table are small apertures which open to the water underneath, and thus afford the opportunity of fishing while sitting at table. Any aquatic prey thus obtained may be dressed in a multum-in-parvo cooking apparatus on board, the smoke from which is conveyed through the bird's neck, and out at its nostrils. In the breast of the bird is a ladies' cabin fitted up as a boudoir." The *Swan* was of about 5 tons register, and when fully stored and carrying 15 persons, only drew 17 inches of water. About the only thing of which the inventor had not thought was to make one eye green and the other red, to represent ship's lights.

The only ship of her kind ever built with a hot-air engine was the *Ericsson*, named after her inventor and generally called the *Caloric*, because of her peculiar engines. These had four immense cylinders which drove paddle-

wheels 32 feet in diameter, the energy being transmitted by a contrivance Ericsson invented and termed the "regenerator." The shape of the furnaces and the small amount of fuel they required, together with the absence of boilers, enabled a greater amount of space to be devoted to the accommodation of merchandise and passengers. The vessel was 250 feet long, 40 feet broad, 31 feet deep, and had a gross tonnage of 1920. She was built in 1852, of wood, and was asserted to have made a speed of 12 knots an hour on her trial trip, but she never came anywhere near this subsequently.

The absence of funnels and the presence of two large paddle-boxes made her one of the most extraordinary vessels ever seen. She made one slow journey across the Atlantic to Liverpool and back to America, and after another set of caloric engines had been tried in her with about as much success, in regard to her speed, as the first, she was fitted with engines of the ordinary type.

Three other inventions which have not yet passed the experimental stage are the Hydrocurve, the Hydroplan, and the Hydroplane.

The hydroplan is a motor-boat carrying two enormous propellers, one above the stem and the other above the stern, which revolve in the air and not in the water. The vessel is said to have been invented by a gentleman named Fortanini, and with a 70-horse-power motor is claimed to have attained, on Lake Maggiore, two or three years ago, a speed of 40 miles an hour. For all practical purposes the hydroplan may be described as a "skimming dish" hull gliding on the surface of the water, its draught being a few inches only.

For some time past some attention has been directed to the trials, on the Illinois River, of a curious type of aquatic motor, named the hydrocurve. Instead of ploughing through the water, the hull of the hydrocurve displaces the water, not sideways as with an ordinary type of vessel,

but downwards from the surface, each particle of water being moved in one direction only. According to a report published in the *Popular Mechanic* of Chicago, this curious vessel on her first trial made a speed of 35 miles an hour. In a further test she achieved $1\frac{1}{8}$ mile in 1 minute 30 seconds, or, roughly speaking, 45 miles an hour. She is 40 feet in length and carries an 80-horse-power motor. The bottom of the boat is concave, lengthways and across.

The theory that with an increase in speed the tendency of a ship is to rise, so that when travelling at a fast rate she will draw less water than when going slowly, and consequently will have less resistance and less skin friction, has attracted the attention of naval architects for many years. So far as theory is concerned, there is nothing to prevent a vessel being built on this principle, but when it comes to considering stability, it is another question altogether. The principle is based upon the well-known theory that if the hull of a vessel be made flat in the bottom and inclined slightly, so that it forms an inclined plane, the vessel will rise to an extent governed by the speed at which it travels. The Rev. C. M. Ramus, of Rye, Sussex, in 1872 improved on this theory by making a flat bottom in two inclined planes, one behind the other, so that each should have an equal lifting power. The Admiralty tested several models made by him, but without satisfactory results, probably due to the comparative inefficiency of the screw-propelling machinery of the period. An American engineer, named Fauber, taking advantage of improved propelling machinery, designed a vessel on these lines with hydroplanes attached directly to the bottom, and a year or two ago it carried six persons at a speed of 35 miles per hour. If a vessel of this size can be constructed and retain its stability, there is no reason why one of much greater size should not be built. The development of the principle is that the planes should be placed at some distance below the bottom of the hull, so that when the vessel travels at a

considerable speed, it shall rise out of the water and be supported by the planes, which shall skim along the surface. This, however, can only be achieved at present by sacrificing stability to speed. An improvement in construction is to shape the bottom of the hull like a very wide letter V, with a series of planes underneath. It is claimed that an ocean liner can be built on this system, carrying six propellers arranged in three pairs, and that the necessary air would be pumped under the vessel by the action of the propellers as she travelled along.

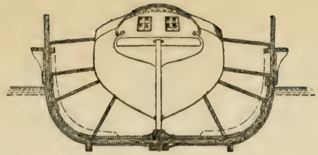
A steamer on wheels, but intended to travel on the water, was invented a few years since by a Frenchman named Bazin. He constructed a model, which worked well and was on the scale of one-twenty-fifth of the liner he hoped to see built some day. The model consisted of four pairs of hollow wheels or discs, each wheel being in appearance like two immense soup-plates set face to face and set on edge. These wheels were caused to revolve, thereby reducing the friction of the water to a minimum, and the vessel was propelled by a screw. The decks, being built on a framework over the axles, had space for ample accommodation, and in order that the speed of the ship should not suffer it was intended to carry no cargo. A vessel on this plan was constructed and launched on the Seine. The platform was 126 feet long by about 40 feet wide, and each wheel was about 32 feet in diameter and about 10 feet at its greatest width. The total weight of the boat was about 280 tons. The boat proved her utility when tried. The inventor estimated that an ocean-going liner constructed on this system would easily cross the Atlantic at a rate of thirty knots an hour.

It is impossible to say what the development of the steam-ship will be in the future. The piston engine has probably reached its utmost development, or very nearly so, and much more in that direction is not to be expected. Naval architects are already considering whether the

existing lines of the steam-ship are the best for speed, and a design has been brought out for a steamer constructed on what are known as tetrahedral lines. There has recently been described in the *Scientific American* a vessel, a model of which has been constructed, designed upon this tetrahedral principle. It is contended that this form for ships offers less resistance than any, and that by it alone can the greatest attainable speed at sea be reached. Yarrow boilers with Schultz turbines are recommended for vessels of this type.

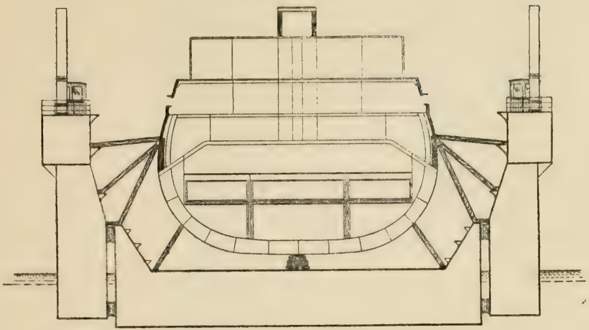
A proposal for fast Atlantic travelling, which has not gone beyond the paper stage, is that three long narrow hulls should be built parallel to each other and supporting the main body of the hull. The inventor claims that the method would enable a greater speed to be attained than by any existing liner, and at a less cost ; but readers who have followed the development of the steam-ship will recollect that this suggestion provides a curious parallel to the experiments of Patrick Miller with his triple-hulled boats in the eighteenth century.

Few, however, will doubt that, great as have been the changes in shipbuilding and steam-propulsion during the last hundred years, there will be changes as great in the present century.



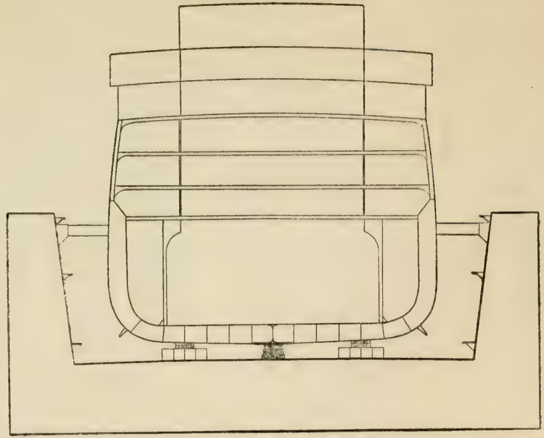
C. Watson's Dock at Rotherhithe, lifting H.M. Brig "Mercury."

From Watson's Specification.—A.D. 1785.



The Bermuda Floating Dock, lifting a 15,000-Ton Ironclad of the "Majestic" Class.

From the Contract Drawings.—A.D. 1900.



The Vulcan Co.'s Floating Dock for Hamburg, lifting a 36,000-Ton Ship of the "Mauretania" Class.

From the Contract Drawings.

The Evolution of Floating Docks, 1800–1910.

BIBLIOGRAPHY

ADAMSON, A. Sea-borne Traffic. (Paper read before the Institute of Marine Engineers.)
AISBITT, M. W. Shipbuilding Ancient and Modern.
AMERICAN "Fall River" and "Hudson River Day" Lines, publications of.
AMERICAN "Merchants' Magazine."
AMERICAN Report of the Merchant Marine Commission.
APPLETON'S Cyclopædia of American Biography. 1887–9.
BATES, CAPTAIN W. The American Marine.
BOURNE, JOHN, C.E. Treatise on the Screw Propeller, Screw Vessels, and Screw Engines.
BRASSEY'S Naval Annual.
BUCKWELL, G. W. The History of the Newhaven and Dieppe Service. (Paper read before the Institute of Marine Engineers, 1891.)
"CASSIER'S MAGAZINE."
"CENTURY MAGAZINE."
CHANNING, E., and LANSING, M. F. The Story of the Great Lakes.
"CHAMBERS' JOURNAL."
CLARK, LYONEL E., M.I.N.A. Floating Docks.
COLDEN, CADWALLADER C. Life of Fulton.
CUNARD LINE, HISTORY OF. 1886.
"DAILY NEWS."
DICTIONARY OF NATIONAL BIOGRAPHY.
DICTIONNAIRE UNIVERSEL.
DREWRY, T. Propellers.
ENCYCLOPÆDIA BRITANNICA.
"ENGINEERING."
"ENGINEER," THE.
FURMAN, FRANKLIN DE R., M.E., and HUMPHREYS, A. C., M.E., Sc.D., LL.D. A History of the Stevens Institute of Technology. 1905.
GOODEVE, T. M., M.A. The Elements of Mechanism.
—— Text-book on the Steam-engine.

HALDANE, J. W. C. Atlantic Liners and their Engines.
—— Steam-ships and their Machinery. 1893.
HALL, HENRY. American Navigation.
—— Shipbuilding Industry of the United States.
HOLMES, SIR GEORGE, C.V., K.C.V.O., C.B. Ancient and Modern Ships. 1906.
HULLS, J. H. Lecture on the Introduction of Steam Navigation. (Delivered before the Institute of Marine Engineers, February 6, 1906.)
"ILLUSTRATED LONDON NEWS."
"ILLUSTRATED TIMES."
INMAN LINE OFFICIAL GUIDE.
"INTERNATIONAL MARINE ENGINEERING."
JOHNSON, R. W. The Making of the River Tyne.
JOURNAL of the American Society of Naval Engineers.
KENNEDY, JOHN. History of Steam Navigation. 1903.
KNIGHT'S Encyclopædia.
LATROBE, J. B. A Lost Chapter in the History of the Steamboat.
LINDSAY, W. S. A History of Merchant Shipping.
—— Our Merchant Shipping.
LINK OF EMPIRE, A: or Seventy Years of British Shipping. (Souvenir of the Seventieth Year of Incorporation of the Royal Mail Steam Packet Company.) 1909.
"LIVERPOOL JOURNAL OF COMMERCE."
"LIVERPOOL COURIER."
MACFARLANE. History of Propellers.
MAGINNIS, A. J., M.Inst.C.E. The Atlantic Ferry: Its Ships, Men, and Working. 1900.
MARVIN, W. L. The American Merchant Marine.
"MASTER, MATE, AND PILOT." (New York.)
MECHANIC'S REGISTER.
MORRISON. American Steam Navigation.
MORSE, J. T., jun. Benjamin Franklin.
MURRAY, ROBERT, C.E. Rudimentary Treatise on Marine Engines and Steam Vessels; together with Practical Remarks on the Screw and Propelling Power as used in the Royal and Merchant Navy. 1852.
"NAUTICAL GAZETTE."
"NAUTICAL MAGAZINE."
NIMMO, J., jun. American Treasury Department's Report, 1870.
ORIENT LINE GUIDE.
PALMER'S Shipbuilding and Iron Company. Some Account of the Works of. 4th edition, 1909.

Parsons, Hon. C. A. The Development of the Marine Steam Turbine. (Paper read before the Institute of Marine Engineers. Sept. 29, 1906.)

P. & O. Company's Handbook.

"Penny Magazine."

Phillips, Sir R. A Million of Facts.

Renwick, James. Robert Fulton. 1845.

Seaton, A. E. A Manual of Marine Engineering. 1890.

"Scientific American."

Semmes, Captain Raphael. Voyages of the *Sumter* and *Alabama.*

Sennet, R., and Oram, H. J. The Marine Steam-engine. 1898.

Shaw, Savill and Albion Co.'s Guide.

"Shipbuilder," The.

"Shipping."

"Shipping Illustrated."

"Shipping World," The.

Sinclair, A. Two Years on the *Alabama.*

Smith, J. Russell. The Ocean Carrier.

Sparks' Library of American Biography.

"Standard," The.

"Steam-ship," The.

Stevens, Francis B. The First Steam Screw Propeller Boats to navigate the Waters of any Country. (Reprint from the Stevens Indicator, Vol. X., April 1893.)

Stretton, Clement E., C.E. The History of the Holyhead Railway Boat Service. (A Paper read on the occasion of the Jubilee of the Railway Companies' Working, August 1, 1898.) 2nd edition (enlarged), 1901.

"Times," The.

Transactions of the Institute of Marine Engineers.

Walliker, J. F. Twenty Years of Progress in Cargo-boat Machinery. (Paper read before the Institute of Marine Engineers, Feb. 12, 1900.)

Watson, Colin. Doubly in Crown Service.

Wells, D. A. Our Merchant Marine.

Williams, Harry, R.N. The Steam Navy of England, 1893.

Williamson, Captain James. The Clyde Passenger Steamer: Its Rise and Progress during the Nineteenth Century. 1904.

INDEX

(N.B.—All vessels are indexed under Ships named.)

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

Printed by Ballantyne & Co. Limited
Tavistock Street, Covent Garden, London